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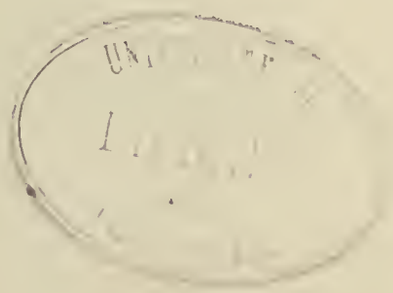

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THE

PRACTICAL MECHANIC'S JOURNAL.

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EXHIBITION OF THE INDUSTRY OF ALL NATIONS IN 1851.

In our number for December last, we have already taken some notice of the proposed grand exhibition. Professing by our title to make these pages a vehicle for information as to the progress of mechanical science, we take a deep interest in the proposed exhibition, as likely to be of great benefit, not only to the spread of mechanical and practical science, but also of arts and civilization in general. Much has lately been spoken and writteu upon the subject, and the public voice, by the press and by public meetings, has heen raised nearly unanimously in its favour. Some may say, and not without a show of truth, that popular opinion, especially when it goes along with rank and fashiou, may often be found erring; and we believe such to be the fact when any project is brought forward which favours popular prejudices, and wins the good opinion of the most ignorant part of the community. But we think it is otherwise when popular opinion results from the deliberate convictions, not only of those moving in the circles of rank and fashion, but of the thinking men of opposite parties in all classes of the community; and when, if prejudice come at all into action, it would militate againust the matter proposed.

If any prejudice can be said to exist among the people of this realm, it is against, and not in favour of, foreign nations; and although it may be hoped that national enmity, engendered by the wars, is well nigh worn out, yet it is still not an unheard-of cry amongst both our agriculturists and manufacturers—"Protect us from foreigners."

However, let not our readers suppose that we have given in our adhesion to the plan of the proposed exhibition because it is popular; to do so, in our estimation, would degrade us as public journalists, equally with endeavouring to court notoriety by running a tilt against it. We propose to lay before our readers the principal reasons in support of it, and to let them judge for themselves.

First, in the words of the royal commission, recently issued, the proposed exhibition "is calculated to be of great benefit to arts, agriculture, manufactures, and commerce."

Our readers are no doubt aware that exhibitions of this sort are not new, either here or abroad, and the one now in question differs from preceding ones chiefly in extent and comprehensiveness. The Royal Agricultural Society has held exhibitions of stock and implements for some years past—so has the Highland Agricultural Society. Exhibitions of manufactures and works of art have been held at Glasgow and at Birmingham, and on a small scale in London by the Society of Arts, and they have been attended with success. The people of Great Britain are slow in being roused to combined action, and the Government has not here, as in foreign countries, been used to interfere directly in affairs of commerce or art; and to this cause is mainly to be attributed our not having had national exhibitions of the products of industry long ago. Until comparatively a recent period, public opinion has not been sufficiently ripe to carry out the idea with success; and without the support of the public as contributors, any such scheme must necessarily fail, as did the National Repository in 1828, although we are inclined to think that, with a little more perseverance than was shown on that occasion, and some stimulus in the shape of prizes, a national exhibition might, even then, have stood its ground. As it is, foreign countries have obtained the start of us, and similar exhibitions have been organized in France, Belgium, Italy, Austria, Spain, Prussia, Sweden, Bavaria, and even Russia. To France, where they have been longest established—the first exhibition was opened in 1798—we must look for an example of the public benefits which are to be conferred by such competitions. The demand which exists amongst persons in this country of means and refined taste, for French silks, lace, china, bronzes, carpets, cabinet-work, and numerous other articles which depend upon superiority of design and execution, sufficiently attests the high standard of taste and excellence produced in France by the expositions—a standard which the greatest men of that country, whether under the republic, the empire, or the monarchy, have ever endeavoured to preserve and elevate by encouraging them. Every successive exposition has drawn a larger number of exhibitors, and produced a more splendid display of improvements, by many of which, not France alone, but our country has profited.

It is a curious fact that, until the last year, all the French expositions have been limited to arts and manufactures, and that the products of agriculture have not been included; while in England the exhibitions of the Royal Agricultural Society have been established some time, but we have no national exhibition of manufactures. The contrast between the general excellence of French manufactures and the miserable state of French agriculture, presents a forcible argument in favour of the expositions.

In our own country, the stimulus given to agriculture and horticulture, by exhibitions and prizes, cannot be denied; and we see no reason to mistrust the result of the same principle applied to arts and manufactures.

Auother advantage of such exhibitions is, that, like periodical rests in the books of merchants, they ascertain the profit and loss to material civilization which may have occurred in preceding periods. Any retrograde movement is at once perceptible; and the advance made on previous periods, acts as an obvious encouragement to industry.

The exhibition will be of great utility by forming a focus, to which will be attracted all that is note-worthy in the various departments of productive art, and thereby economizing the time and labour of those desirous of perfecting their several manufactures. Many ingenious contrivances and valuable productions, if not lost altogether, have remained for years restricted in their employment to one country, or even to one province, from the lack of some common centre where they may be brought under the gaze of the rest of mankind,—and such a centre the proposed exhibition will supply. This principle of centralization is to some extent carried out in such great emporiums of commerce as London or Paris; but with all the splendour of the shops of our great towns, the *Times* has very justly remarked, "it is very difficult to obtain a good survey and estimate of our industrial state."

The contemplated exhibition will bring within the compass of a single building, samples of the labour and ingenuity of the greater part of the inhabitants of this earth.

The manufacturer may there find new materials for his work; the engineer new applications of mechanical power; the artisan may discover new and economical methods of applying his labour; and the artist new ideas of beauty and excellence. New markets may open to the merchant for his wares, and an immense choice of all things fitted for the use and luxury of man will lie open to the consumer.

Civilization will benefit exactly in proportion to the fidelity and energy with which the great idea is worked out, not only by its conductors, but by the people themselves.

Another tendency of the exhibition, which has been much dwelt upon, is, that it will cement the amicable relations of all the nations of the earth; that it will "rub the sharp corners of many nations off." Other countries have been gifted with natural productions which ours has not, and maybe their inhabitants have likewise been gifted with an aptitude for certain pursuits which we have not; and we desire a fair exchange with our own. Conscious that, to compete with the world, we must avail ourselves of all that human intelligence has discovered in other lands, we invite all other nations to compete with us in a friendly spirit, that we may learn as well as teach,—and not to make an arrogant boast of universal superiority. We ask them to forego jealousy and petty prejudices, and to exchange freely with ourselves the development of that intelligence given by God to man, without distinction of nation, and to unite in forming the most splendid exhibition yet seen, of the triumphs of that intelligence over the material creation.

We take an interest in foreigners as our customers, and they take a similar interest in us; this will lead us to take an interest in each, on nobler grounds, as fellowmen. With a more complete knowledge of each other, and our own true mutual interests, hostility will cease. We take leave to borrow a few words from the eloquent speech of the Earl of Carlisle at the Westminster meeting. It is right "that industry, skill, and enterprise, should have in turn their own ovations, their own triumphs, their own high holiday, when the workmen and workwomen of the world may escape for a time from their unceasing toils, for the purpose of seeing what their fellow-workmen are doing, and can do, all the world over; that they may see, not barbaric rites, but useful inventions; not exhibitions of physical prowess in the prize-ring or the foot-race, but results which interest the mind and elevate the soul; not the crowded saloon and heated theatre, but the arena where all ranks may mingle, where all may learn and all may profit by what they see."

With regard to the £20,000 intended to be awarded for prizes,—while approving of prizes in principle, we are not insensible to the difficulties in the way of obtaining a satisfactory distribution of them. It cannot be denied that large numbers would exhibit without prizes, and that specimens of industrial art would be sent for exhibition, sufficiently satisfactory to show the present state of industry. But that alone would be falling short of the object of the exhibition, which is to excite such an emulation as may conduce to the improvement of industrial art, and show progress. This it is hoped to attain, partly by the public distinction which will be gained by the successful competitors, and partly by prizes. The incentives to exertion are diverse in different men. Some will look mainly at the honour and distinction to be obtained. Some will think the only prize worth having, to be the commercial success of the article produced; and others will look only at the pecuniary value of the reward. We think the prizes ought to be considered as the rewards of the extra exertion which may have been employed in the production of articles for the exhibition. It is desired not only to produce articles already known, but some that are new, or have some new excellence. Such production is always attended with risk, and much labour must often be lost before attaining the object.

To many wealthy manufacturers the prizes may not supply a motive, but that is no reason they should not exercise a powerful influence on poor inventors;—witness Jacquard, whose great abilities were first turned to the subject of the loom, by reading an advertisement of a premium offered by the English Society of Arts, and who subsequently obtained prizes at the French National Expositions.

In our former article we were only able to announce the general idea of the exhibition, as brought forward by Prince Albert, and taken up by the Society of Arts; and we now give a hasty sketch of its progress and development since. On the 7th November last, the first practical step for establishing the exhibition was taken by the execution of a formal contract, by deed, between certain trustees for the Society of Arts, and Messrs. James and George Munday, contractors for public works. The Society not being authorised by their constitution to carry out alone so extensive an undertaking, were fortunate enough to find these capitalists ready to undertake the responsibility, without any other security than their confidence in the public support it would receive, and to indemnify the Society from all expenses and liabilities connected with it. Those gentlemen not only contracted to furnish the sum of £20,000 for prizes to the exhibitors, but to erect a capacious building, alone calculated to cost £50,000, wherein the exhibition might be held. All that was secured to them was the site for the building, which was to be provided by her Majesty's Commissioners of Woods and Forests.

It was stipulated that the subscriptions to be received from the public were to be first applied in reimbursing the contractors their capital, with interest at five per cent.; and if any surplus remained, two-thirds of it was to constitute their profit. Attempts have been made to represent this contract as a job. If by this is meant merely that the parties undertaking the responsibility of the exhibition meant to secure for themselves some portion of the profit, this charge is undoubtedly true; but if by job is meant any unfair preference or advantage, the charge is refuted by the power reserved by the contract itself to the Society, or to the Royal Commission, if one was issued, to revoke the contract at any time upon repayment merely of monies actually advanced, with interest. The terms of the contract were extensively made known, and the contract lay open to public inspection at the rooms of the Society of Arts for some time. The public appear to have been secured all possible advantage, and we cannot but consider that the commissioners were justified in their statement, that, in agreeing to it at a time when the success of the scheme was necessarily still doubtful, the Messrs. Munday evinced a most liberal spirit.

With the new year came the royal commission, which bears date the 3d January, whereby her Majesty appointed Prince Albert, the Duke of Buccleuch, the Earl of Rosse, Earl Granville, the Earl of Ellesmere, Lord Stanley, Lord John Russell, Sir R. Peel, H. Labouchere, W. E. Gladstone, Sir A. Galloway, or the Chairman of the Court of Directors of the East India Company; Sir Richard Westmacott; Sir C. Lyell, or the President for the time being of the Geological Society; T. Baring, C. Barry, T. Bazley, Richard Cobden, Mr. Cubitt, or the President for the time being of the Institution of Civil Engineers; C. L. Eastlake, Thomas Field Gibson, J. Gott, Samuel Jones Lloyd, Philip Pusey, and William

Thompson, commissioners, to inquire "into the best mode by which the productions of our colonies and of foreign countries may be introduced into the kingdom; the best site for the exhibition, and the general conduct of it; also into the best mode of determining the nature of the prizes, and securing their impartial distribution." Authority was also given to these commissioners to appoint local ones in this and other countries; and the following gentlemen were named as joint-secretaries:—J. S. Russell and S. H. Northcote, Esqrs.; Robert Stephenson, Esq., M.P., H. Cole, C. W. Dilke, G. Drew, and F. Fuller, Esqrs., were appointed as an executive committee, with Matthew Digby Wyatt, Esq., as their secretary. Mr. Stephenson having since been nominated by Her Majesty one of the royal commissioners, Lieutenant-Colonel Reid has been appointed chairman of the executive board.

As one of the great characteristics of the proposed exhibition is to be its universality—as it is to comprise the productions of the most various and even hostile nations, and the most opposite climes,—so does the commission include the representatives and leaders of the most opposite political parties, and of the most varied professions. It must be a peaceful object which can unite in harmony men of such opposite opinions upon some subjects, whose public life has been occupied in continual hostility to each other. Such a combination is not only the best check that could be devised to prevent jobbery, and to secure the impartial distribution of the prizes, but also the best means of insuring the largest possible number of supporters, whether as subscribers or exhibitors. Had the commissioners been selected from one party only, or from one of several rival professions, the allegation would certainly have been made, whether fairly or unfairly, that their conduct was influenced by political or professional bias.

The commissioners met for the first time on the 10th January, and their first step was to cancel the contract with the Messrs. Munday, pursuant to the proviso contained in it for that purpose, notwithstanding they considered it, in a pecuniary point of view alone, advantageous to the public; the commissioners feeling that the experiment was of a national character, and that it ought to rest for its support upon national sympathies, and upon such contributions as those sympathies might dictate.

To carry into effect the objects of the commission, required an amount of continuous labour, and a devotion of a larger amount of time, than could be expected from men whose time was already much occupied in public affairs of paramount importance, and therefore the expedient of appointing an executive committee of gentlemen of less public note, but better able to afford their time and labour in carrying out the measures approved by the general body of commissioners, was, as we think, wisely adopted. Had such a plan been resorted to in reference to another royal commission, the most important part of its executive duties would not have been left to the secretary, and the necessity for the painful disclosures recently made would never have occurred.

The head-quarters of the commissioners have now an appropriate place in the new palace at Westminster. The executive committee have not been idle; public meetings have been held under the auspices of the commission in many of the principal towns of Great Britain. Measures are actively progressing for organizing committees and raising subscriptions all over our empire. The initiative was taken in London by a meeting at the Mansion-house, over which the Lord Mayor presided. Lord John Russell, Lord R. Grosvenor, the Earl of Granville, Baron Rothschild, Mr. Hume, and other members of Parliament, advocated the cause, which was responded to at the meeting by a subscription of upwards of £10,000. Another important meeting was held in the city of Westminster, on the 21st February, where the Bishop of Oxford, Lord Carlisle, Lord Brougham, and other distinguished personages, eloquently supported it. The diplomatic representatives of France, Prussia, Belgium, and the United States of America, pledged themselves to support the exhibition on behalf of their respective nations.

The Duchess of Sutherland and other ladies of fashion, have organized a ladies' committee to collect subscriptions. Symptoms of support from abroad have already appeared. M. S. Dumas, the French minister of agriculture and commerce, has brought the subject before his Government, and given instructions to the prefects of departments to take steps to sustain the honour of French industry.

A minutely classified list of objects for exhibition has been prepared by the commissioners, divided under the following heads:—

1. Raw materials and produce, illustrative of the natural productions upon which human industry is employed.

2. Machinery for agricultural, manufacturing, engineering, and other purposes, and mechanical inventions, illustrative of the agents which human ingenuity brings to bear upon the products of nature.

3. Manufactures, illustrative of the result produced by the operation of human industry upon natural produce.

4. Sculpture, models, and the plastic art generally, illustrative of the taste and skill displayed in such applications of human industry.

For each of these sections committees have been appointed, composed of men of the highest attainments in science and art; and to a separate committee has been committed the charge of all matters relating to the building.

The 1st of May, 1851, is the day very suitably fixed for the opening of the exhibition, as it coincides with the London "season," and many strangers arrive from the country to attend the meetings of religious and philanthropic societies held in that month. The building is to be erected upon that part of Hyde Park adjoining Rottenrow, as before suggested, and will be fire-proof, of one story elevation only, but of an extent of from 700,000 to 900,000 square feet. The committee have invited suggestions from all parties as to its general arrangement.

All articles intended for exhibition are to be delivered at a place to be named by the commissioners, between the 1st January and the 1st March, 1851, at the expense of the owners, but the commissioners will take charge of them, free of expense, from the time of delivery. Articles from abroad are to be admitted without payment of duties, but are to be deemed bonded goods.

Upwards of eighty local committees have been appointed in this country, and the commissioners desire information from them of the articles proposed to be exhibited from their several districts, to aid them in determining, as soon as possible, the extent of building which will be required.

In the execution of a project of such immensity, it is impossible that even the general details of the arrangements can be duly settled upon or explained at this early stage. It is a fact that there is to be an exhibition, open to all the world, and begging all the world's assistance. If we respond heartily to the call of the originators, the success of the gathering will be such as will astonish the whole world at its own productions; if we do not, by so much will the value of this most eloquent of all industrial expositors be diminished. But whoever has watched the current of public opinion will agree with us, that there is no fear of a lack of energy—no chance of a dearth of contributions; and he who wittingly withholds his meed of assistance, whether it is as an industrial contribution, a pecuniary lift to the exhibition treasury, or that most essentially necessary element, a stirring interest in the movement, will simply enjoy the very equivocal pleasure of being witness to a success, to which he has lent no helping hand,—to a magnificent result, of which he is an idle spectator. The goal will be reached—the display will be made—let us all then earn the satisfactory consciousness of being, in some way or other, valued agents in its consummation.

If objections or difficulties arise as to the actual working out of the details of the exhibition—for in point of principle, we are persuaded, none exist—let these be at once removed or mitigated by the suggestions naturally arising as remedies. The royal commission is prepared to execute its office in precise accordance with the stated wishes of the people. It awaits their suggestions; and whatever proposed plan may be found to jar with the popular feeling, it must be remembered that such

proposition is merely brought forward as a suggestion in itself, and not as an inflexible rule.

Numberless cases for discussion will arise, and to settle these in the most effectual manner, the various local committees must forward the result of the balance of opinion in their districts to the proper quarter for consideration. In this way we shall soon arrive at a settled adjustment of terms fit for universal acceptance, and pave the way for what we are bound to consider as promising to be a splendid epoch in the history of the world's industry.

WHITELAW'S CENTRIFUGAL PUMPS FOR SHORT LIFTS, AND CENTRIFUGAL CHURN.

(Illustrated by Plate 45.)

Where large quantities of water are to be lifted to moderate heights, as in drainage or irrigating works, centrifugal power presents many advantages as the medium of elevation. The machinery required for carrying out the principle is of the simplest kind; the movement is nothing more than an even continuous revolution, and the quantity of water raised, or the duty obtained, is, as we shall show, of very important amount. Still, with the exception of the appearance of a few scattered sketches, giving a dim notion of the theory of the action of centrifugal force as an elevator of fluids, pumps of this class were very little known until Mr. James Whitelaw of Johnstone, so favourably known for his improvements in the reaction water-wheel, brought forward the subject in a really practical form.

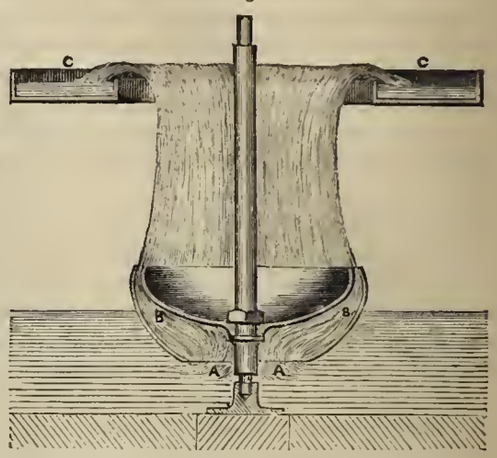
Some three or four years ago, this gentleman was led to consider the application of this form of pump for drainage, by the occurrence of a convenient practical opportunity for testing it, in removing the water from a piece of low-lying meadow land in his own immediate neighbourhood. For reasons not bearing upon the pump itself, the plan went no further than a mere proposition, but was sufficiently matured to afford a fair idea of its suitability for the purpose. It does not require to be "fanged" before it will lift, for, immediately that it is set in motion, the water rises without any coaxing, and at once issues from the discharging orifices. Its mechanism is essentially free from complexity; and as there are no pistons, valves, or other small details, there is actually nothing to get out of order, even with the worst usage which machinery of this kind can meet with, for roots, pieces of wood, or stones, will easily pass through, unless very large, when their removal causes little inconvenience. It has also the advantage of non-liability to injury from oxidation in standing idle, which is so generally fatal with the polished surface of pump barrels, for every exposed part may be galvanised, or painted so as effectually to preserve it

In our plate 45, fig. 1 represents the pump in elevation, with a portion of the external casing torn off, in order to show the form of the jet-pieces; fig. 2 is a plan or top view of the pump; fig. 3 is a sectional elevation; and fig. 4 is a horizontal section corresponding. The water to be lifted is conducted into the well, A, by the channel, or conduit, B, in connection with the water supply. The rotatory movement of the pump is obtained from the horizontal shaft, C, driving the vertical spindle, D, by means of a pair of bevel-wheels, as figured on the plate. This spindle carries the hollow conical case, E, and as it revolves at a quick rate, the centrifugal force thus generated causes the water to rise up through the large central orifice, F, spreading over the inside of the external casing, as shown in the section, fig. 3, until it is carried into the jet-pieces, G, when the same force urges it through these channels, and out by the discharge-orifices, H, falling into the circular channel, I, whence it flows off by the upper duct, J. To prevent the entrance of the water, or any impurities contained in it, to the footstep of the spindle a small inverted cup, or air-vessel, is formed upon, or attached to it at K, so that the frictional surfaces here are preserved from the objectionable wear which would otherwise arise.

If a plate, hollowed out to the form of a shallow cup, as represented by the dotted lines at L, in fig. 3, were attached to the upright spindle, it is presumed that it would have the effect of causing the water to flow more freely into the pump, as the vacuum, which the ascending column of water tends to produce, would, no doubt, cause a rush of water into the central opening. Probably an increased advantage might be obtained from a still greater extension of the height of the sides of the plate; and, in constructing the pump, it would be important to ascertain if any additional benefit is to be obtained by carrying up the sides of this plate, until they join up to the flat ring on the top of the casing.

The number of jets is another matter for consideration; and for some purposes, it might be an improvement to make them issue from the outside, instead of the bottom of the space, M, as in fig. 3.

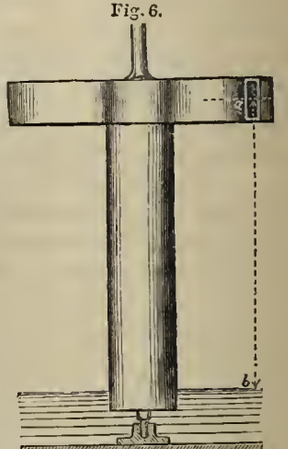
Fig. 5.



The water-spaces in the external casing need not be wider than those marked N, each space being formed by one of the plates, O, and another represented in dotted lines in fig. 4. The breadth of the latter plates is simply sufficient to keep the water out of the spaces, P P; and it is obvious that the diminution of the water-spaces will reduce the weight of the revolving mass.

In the woodcut, fig. 5, is a suggestion for another modification of pump for raising water to inconsiderable heights. The sketch is a vertical section through the two discs, forming the elevating water-space, the water entering as shown at A A, passing up at B B, and finally issuing in an annular sheet, which is caught by the upper basin, C C. In this pump, spiral or inclined blades should be fastened in the space, B B, between the discs, to conduct the water in a direction contrary to that in which the machine revolves, so that it may issue at the point of discharge, with the least possible amount of movement, in the direction of that of the pump itself. The great distinctive feature of this machine, as compared to that in our plate, is, that the water is only for a short distance in contact with the disc surfaces, being elevated above their level entirely by its accumulated momentum. If the line of discharge were made in a direction parallel with the axis of the machine—that is, perpendicularly upwards, it is obvious that the centrifugal force would throw it outwards before it reached the receiver above; and, to counteract this tendency, the upper edges of the discs must be turned inwards, to give the water a slight tendency towards the axis.

Fig. 6.



The experiments, of which we give the results in the following table, were made about two years ago, upon a pump of the form given in fig. 6, the arms of which were of the shape shown in the horizontal section, fig. 7. The height, *a b*, to which the water was lifted, is 1·882 feet, and the diameter of the pump, or the distance, from centre to centre, of the jet orifices, is $18\frac{1}{16}$ inches, or 1·5052 feet. It is driven by a pulley fast on the top of the spindle, motion being communicated to it by two strings, attached at one end to the pulley's periphery, one on each side, and drawn in opposite directions. The diameter of the pulley is ·26 foot, and the strain upon its pair of actuating strings was measured during the trials by a dynamometer of a new and delicate construction; the quantity of water lifted was also accurately measured in a box.

Fig. 7.

The numbers in the 2d, 3d, 4th, and 5th columns of this table were obtained from experiment, and those in the other columns were calculated by the following general rules or formulæ, in which *h* denotes the height the water is lifted in feet; *v*, the velocity in feet per second of the centre of the jet orifices; *f*, the per centage of power that remains in the water after it has left the pump; and R, the per centage of power lost by

Fig. 1.

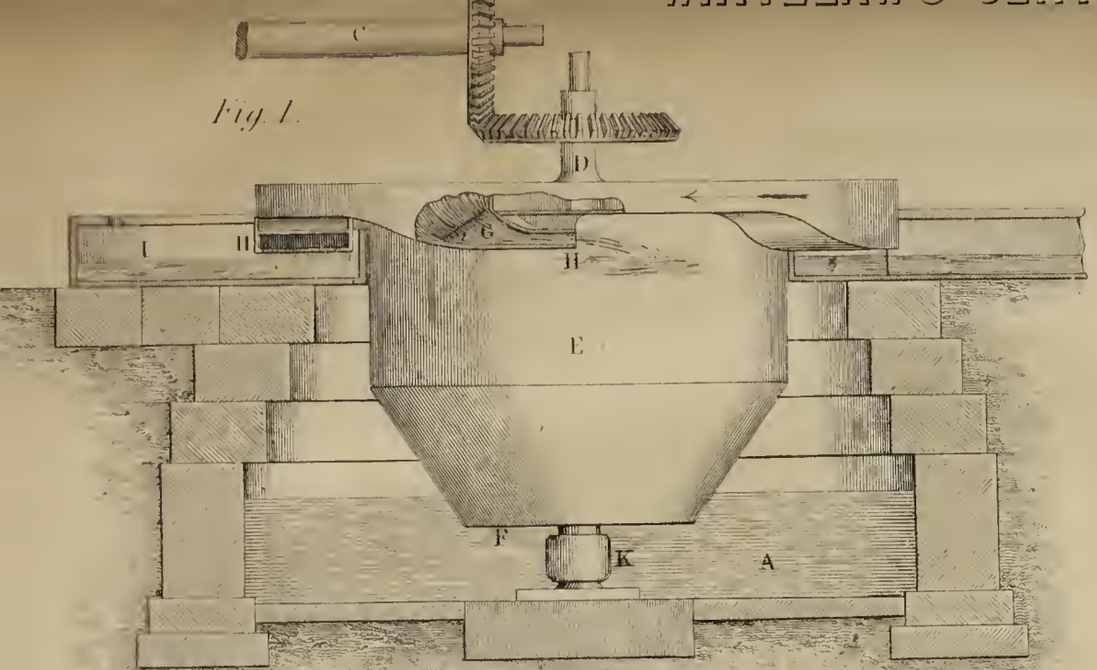


Fig 2.

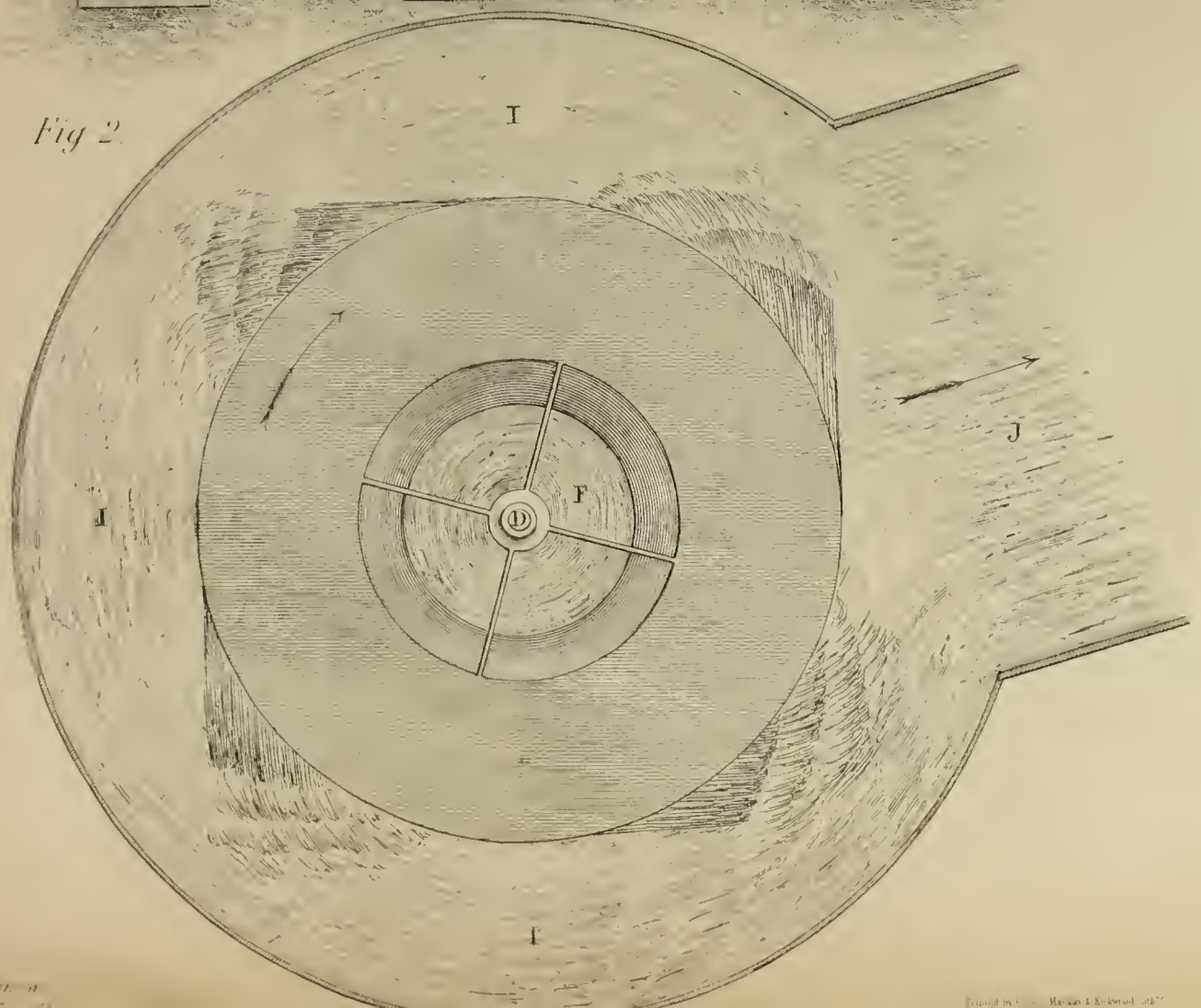


Fig 3.

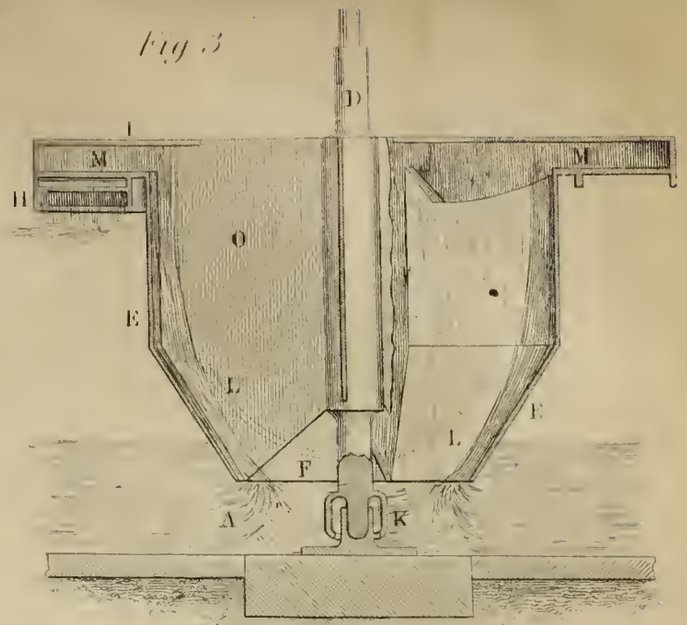
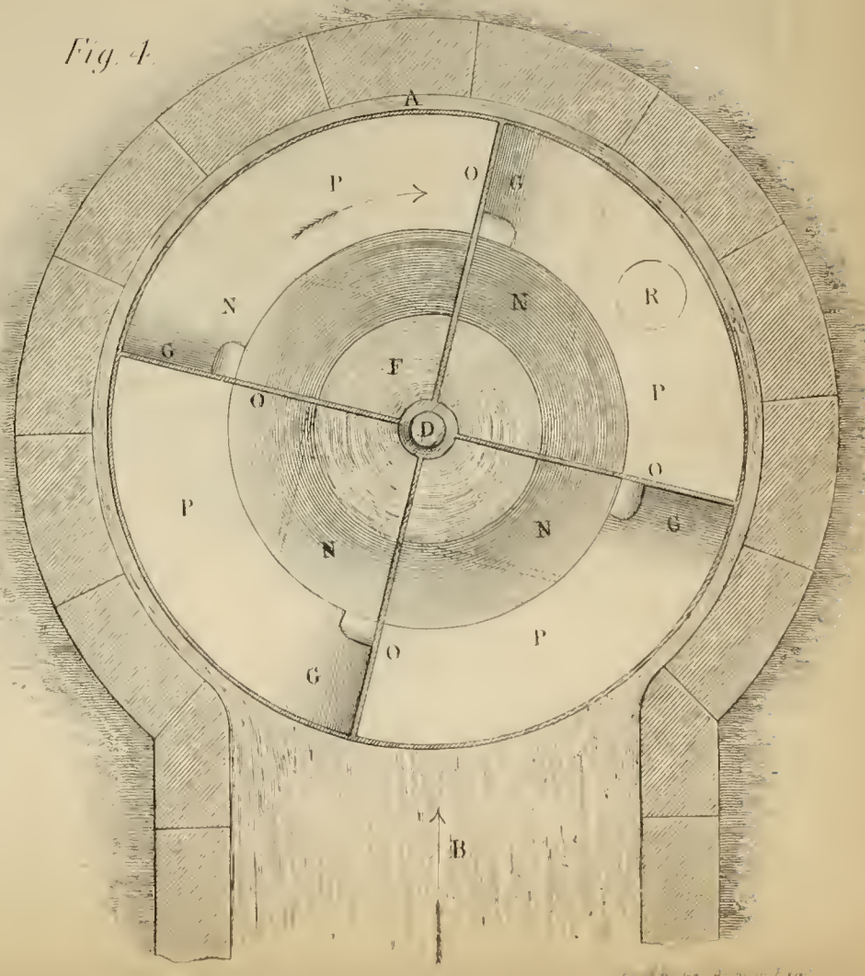


Fig 4.



the resistance the water meets with in passing through the upright tube-arms and jet-pieces of the pump.

Results of Experiments with Model Centrifugal Pump.

No. of experiment.	Actuating force on pulley in ounces.	Revolutions of pump per minute.	Ounces of water raised by pump per minute.	Power of pump, that of motor being 100.	Per centage of loss caused by the resistance the water meets with in passing through pump.	Per centage of loss caused by the water leaving pump with some force remaining in it.	Sum of the numbers contained in the 6th and 7th columns of this table.	100 — the numbers in 8th column of this table.
1	62·90	327·6	6191	69·23	19·370	7·314	26·684	73·316
2	56·58	278·4	5003	73·18	12·780	9·462	22·242	77·758
3	49·55	226·8	3754	76·97	7·027	13·980	21·007	78·993
4	44·51	199·6	2922	75·78	4·466	18·620	23·086	76·914
5	41·07	182·0	2481	76·48	2·984	23·780	26·764	73·236
6	37·59	164·0			1·608	33·010	34·618	65·382
1	2	3	4	5	6	7	8	9

$$\frac{4{\cdot}33\left[\left(\frac{v}{8{\cdot}046}\right)^2 - h\right]}{h} = \mathrm{R}$$

$$\frac{\left[v - 7{\cdot}87\left[\left(\frac{v}{8{\cdot}046}\right)^2 - h\right]^{\frac{1}{2}}\right]^2}{{\cdot}6474\,h} = f$$

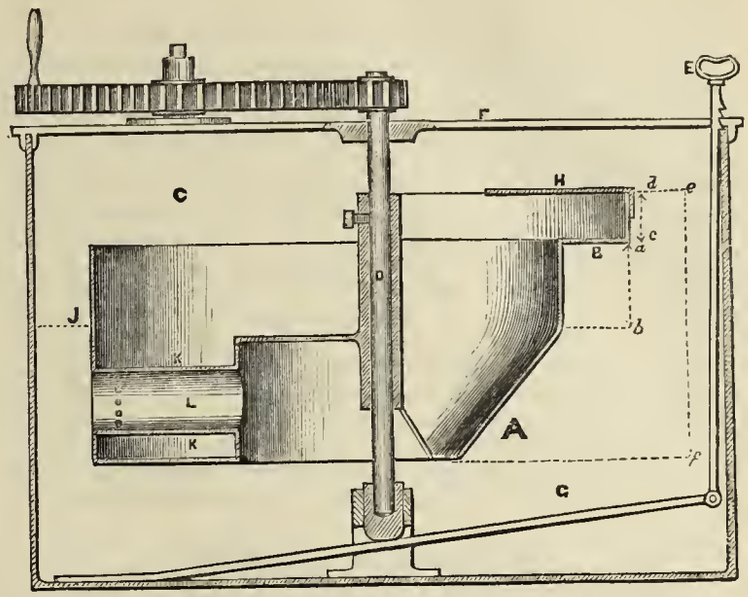
Column 6th of the table was calculated by the first, and the 7th by the second formula; and as these formulæ do not give allowance for the resistance of the atmosphere, it may be assumed, since the 9th column of the table differs so little from the 5th, that the formulæ are correct. And as it happened that the pump was empty when the resistance of the atmosphere, and the loss occasioned by the friction in the bearings of the spindle, was ascertained by the dynamometer, it will be evident that each of the numbers in the 5th column of the table is less than it should be by a quantity equal to that which would represent the power lost in overcoming the friction due to the weight of as much water as the pump will hold, and this makes it still more clear that the formulæ are to be depended on. Either the fourth or fifth experiment (probably the fifth) should have been made a second time.

As the *power required* is no more than is necessary to raise the water, overcome the resistance it meets with in passing through the pump, give the velocity that remains in the water after it leaves the jet orifices, and overcome the resistance of the atmosphere, with that arising from the friction of the spindle in its bearings—if, therefore, the power of the motor be = 100, R + f + the effect produced by the pump = 100, if the friction of the spindle and the atmospheric resistance did not, to any extent, tend to destroy the motion.

Centrifugal Churn.

A model churn was constructed, some time ago, to act on the principle of the pump illustrated in our plate, with this difference, that the cream, instead of issuing from the underside of the space, M, as in fig. 3 of the plate, in a direction opposite to that in which the pump revolves, is projected directly downwards through a series of round holes made in the thin and flat bottom plate of the corresponding space in the churn. One of these holes is represented in fig. 4, there being in the model sixteen of them, placed at equal distances from each other in the middle of the breadth of the bottom plate, as marked at R. This churn makes butter very quickly, and is easily worked. The side marked A, in the sectional elevation of the churn, fig. 8, explains the details of this churn, B being one of the discharging orifices. These are each ½-inch diameter, and the top part of the revolving casing is 10 inches in diameter, whilst the upper part of the conical casing is 8 inches in diameter. The central opening in the bottom is 3¾ inches diameter, and the heights, *a b*, *c d*, and *e f*, are 1¾—1, and 5¾ inches, respectively. After trying this churn, it was thought that if the diameter of the top of the revolving case had been 12 inches, and the cone 10, with a central opening of 4⅛ or 4¼, a still better performance would have resulted; but, in other points, the several dimensions were found to be of good proportion. The box, C C, is open at the top, and is 15 inches square, by 10 deep, being filled with milk up to the top of the conical part of the revolving casing. The spindle, D, is driven by a handle in a large spur-wheel of 60 teeth, gearing with a pinion of 11 teeth,—this arrangement being sufficient to give an extremely rapid rotatory motion, causing the jets to issue with great force into the milk in the box.

Fig. 8.



To suit the variable level of the cream in the box, a pinching screw in the boss of the casing admits of an accurate adjustment of the height of the casing; and the handle, E, jointed to a lever passing beneath the foot-step of the spindle, affords a ready means of raising and lowering the revolving apparatus as the cream swells or sinks, the top of the spindle being made to slide in the eye of its driving pinion for this purpose. For convenience in cleansing the apparatus, the top rail, F, is merely laid on and steadied by short end projections, and the cover, H, of the revolving part, is made to lift off the top of the casing, the spur-wheel above being removeable from its stud, whilst the spindle can be taken out by slackening the side pinching-screw.

Instead of causing the cream to pass through orifices in a thin plate, a short tube might possibly be substituted with advantage, and if more air than the jets would carry through with them were required, small holes might be made round each tube, as in fig. 9, for the purpose of the admission of air to the jets, on the principle explained by Venturi.

Fig. 9.

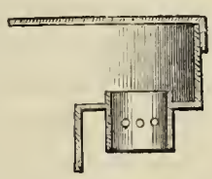
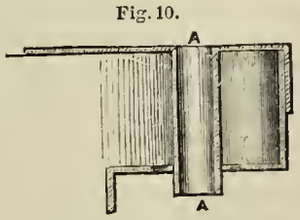


Fig. 10 shows another plan of admitting air. The milk passes through orifices in a thin plate; and concentric with each orifice is a tube, A A, which passes through the top plate of the revolving part, to allow air to rush down through the tubes into the jets. Were the tubes, A A, slightly bell-mouthed at their lower ends, a greater volume of air would pass into the jets. In place of sixteen ½-inch orifices, four of say 1¼ inches diameter, would be large enough to do the same work, if the tubes, A A, were ¾-inch diameter. The same principle may be applied, if, in place of passing the milk through orifices in a thin plate, it is made to run through short tubes.

Fig. 10.



The section on the opposite side of the churn spindle, in fig. 8, shows a different arrangement. Here the surface of the cream is supposed to be level with the point, J, and in the annular space, K, K, are set horizontal radiating tubes as at L, through which the liquid rushes by its centrifugal force, when the machine revolves, and is thus churned. As the cream has not access to the space, K, K, air may be admitted to the tubes, if necessary, by piercing small holes, as in the figure. The fluid would flow more quickly through the tubes, if their inner ends had the *vena contracta* form.

Air may be admitted into the jets or streams, or be made to pass along with them into the milk in the box in various ways, as any one who has studied the action of the water-blowing machine, or read Venturi's account of his experiments, will at once see.

As another hint for the more speedy production of butter in machines of this class, it may be remarked, that if the cream were first forced through very small orifices to break the pellicles, or skins of curd, which cover the small globules of butter, and then sent through larger openings, these globules would unite to form the masses of butter. Thus, if the apertures B, in fig. 8, were made much larger than the powers of the churn could keep full, and that a second plate, pierced with the same number of coincident holes of a smaller diameter, or just the size capable of running off the quantity of milk which would be raised, were placed on that in which the larger orifices are made, the churn would then perform exactly as described in reference to the sectioned side, A, in fig. 8. Again, if in the middle of each space, comprehended between the orifices in question, a sufficient number of very small holes were pierced in the upper plate, and this were placed so that each set of its small holes come over one of the large openings in the other plate, the fluid will be forced rapidly through the small holes; and by simply changing the relative positions of the two plates, the cream may be forced through either the large or the small holes, as occasion may require. In the other arrangement, a plate full of very small holes might be inserted at the commencement of the process in the central opening, and at the proper time this could be dropped down to the bottom of the box, where it could remain until the completion of the process. With the model churn, as at A, in fig. 8, Mr. Whitelaw produced butter in 25 minutes, whilst the person from whom the milk used in the experiment was procured, cannot complete the process in less than 1½ or 2 hours with the common churn.

SOME CRITICAL REMARKS

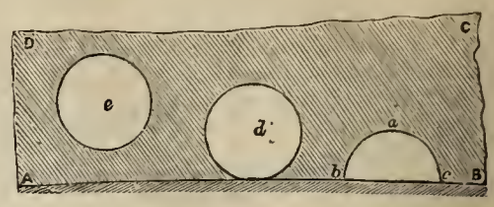
FOR THE BENEFIT OF PROFESSOR POTTER, A.M., AND OTHER AMATEUR TELESCOPE-MAKERS, REGARDING LORD ROSSE'S MODE OF CASTING SPECULA ON A "CHILLING BASE" PERMEABLE TO AIR.

Notwithstanding the great deal that has been said and written respecting Lord Rosse's famous teleseope, the subject does not yet seem to be exhausted. There are still collateral points which afford matter of discussion among the would-be wise. One of these, which has just attracted my attention, is the question raised by Professor Potter, in the *Philosophical Magazine of January*, relative to the casting of speeula on a chilling base.

Lord Rosse's mode of forming the base, consisted in packing hoop-iron edgewise, so closely that the metal, in being poured into the mould, would not pass through the interstices, yet sufficiently open to allow of the escape of air. This is regarded as his lordship's "undisputed discovery." In Lord Oxmantown's "Account of Experiments on the Reflecting Teleseope," published in the Philosophical Transactions for 1840, it is stated that, "at first a simple disc of iron was tried (as the base of the chill); but although the castings were sound, there was this defect,—that bubbles of air were often entangled between the iron and the speculum metal, producing cavities which it was tedious to grind out; the iron disc was therefore replaced by one made of pieces of hoop-iron placed side by side, with their edges up, tightly packed in an iron frame; the edges were brought to a smooth surface of the proper curve, either by the file or lathe, whichever was most convenient. A metallic surface was thus constructed everywhere porous, as, however close the hoop-iron had been packed, the interstices suffered air to pass freely through. So successful was this expedient, that of sixteen plates cast for the three-feet speculum, not one was defective."

Professor Potter admits that if the successful casting of these sixteen plates was due to the base being thus formed of packed hoop-iron in place of a solid disc, it must then be allowed that Lord Rosse's discovery was a great improvement. But he undertakes to show, from the ordinary principles of hydrostatics, that this is not the true explanation; that the cavities which were found on the surface of the first castings upon a solid disc, must be referred to some other cause. The cause he assigns is, that, in the first attempts on the chilling method, the melted metal was not sufficiently fluid for that mode of casting,—that it did not flow uniformly over the disc, but, becoming solid too quickly, left cavities in some places.

This position he essays to demonstrate from the "ordinary principles of hydrostatics." These principles, he contends, are sufficient to inform us, that if the metal retained its fluidity, for ever so brief an interval of time after an air-bubble was entangled between the iron and the melted speculum metal, it must have been displaced by the forces acting upon it. His demonstration is this: Supposing A B to be the upper surface of the chilling base, and *b a c* a portion of air entangled within the melted metal, A B C D. As the pressure at different points in a fluid increases with the depth, the parts at *b* and *c* of the air-cell will be subjected to greater pressure than those about *a;* hence the bubble will instantly take the form denoted by *d*, and ascend as represented by *e*, through the fluid metal, like air-bubbles in water, by virtue of the property of fluid pressure; from which it follows, that the resultant pressure on a body immersed in the fluid, equals the weight of the fluid displaced, and "acts vertically upwards through the centre of gravity of the fluid displaced." The conclusion from this is, that "it is hence futile to prepare a way for escape downwards, when there is no tendency to escape in that direction."



The law of fluid pressure is here given quite correctly, and the deduction is likewise quite legitimate, provided there were no counteracting influences to contend with. But in all reasonings on natural laws, it is always desirable to examine whether the conclusion is not, like the bubble of air, entangled between the law which we apply, and other laws which we overlook. A law is true in any particular case, only to the extent it is not counteracted. This is itself a law equally certain, and quite as imperative as that of hydrostatic pressures, and one which appears to be applicable in the present instance.

Assuming the bubble of air to be formed as indicated in the figure,—if the metal were a perfect fluid, possessing perfectly molecular mobility, and the air quite destitute of all adhesive property,—did no molecular attraction exist between it and the metal of the base, and that in which it is embedded, then we might suppose that the law of fluid pressures would apply exactly as Professor Potter describes,—the air would escape upwards through the melted metal with all expedition. But, in the first place, the speculum metal cannot, by any known application of heat, be brought to the condition of a perfect fluid; it will always possess considerable viscidity, and viscidity is only another name for molecular cohesion. But, in order that the air-bubble may ascend, this molecular force must be overcome by the hydrostatic pressure of the metal; and should it happen that these forces are in equilibrio,—and there will evidently be a temperature of the metal at which they would exactly balance each other as opposing pressures,—there would result all the consequences predicated by experience. A simple conception of this condition is to regard the globule of gas as a solid body moving in a resisting medium; it will move only as long as the impelling force—including the momentum generated in the mass—predominates; and should the impelling pressure *ab initio* happen to be less than the resistance to be overcome, it is very manifest that the air-cell would continue *b a c*, as it is figured, and as we often find it in actual chilled castings, notwithstanding the law of fluid pressures appealed to.

The phenomena which we are in the habit of every day witnessing, of air-cells in contact with iron plates, inserted into moulds for special purposes in iron-casting, appears to me to set aside entirely the elementary demonstration which Professor Potter seems to think so conclusive. Even the small chaplets employed in ordinary founding, when cores are to be supported by that means, are more than troublesome by the cellularity which they produce around them, even when there is every possible facility provided for the escape of the air; and in cases where a division is effected in a casting, by introducing a plate of malleable iron into the mould, the metal is in no instance solid when it comes into contact with the plate, and very frequently the cells are so numerous for some distance back, as to present the appearance of a honeycomb, wanting the beauty and symmetry which the insect structure exhibits. All this is, however, so well known and familiar, that I almost feel an apology necessary to the mechanic, for making it the subject of an explicit statement.

Professor Potter guards himself by saying, that the metal was not sufficiently fluid for the chilling method of casting, adopted by Lord Rosse in his first attempts. It is quite possible that some modification of the evil experienced might have resulted, had the temperature been increased; but in adopting a hypothesis, which seems to imply no very high compliment to the manipulators concerned—some of whom we must suppose were not entirely ignorant of the law of fluid pressures; it was certainly to be expected that Professor Potter would have condescended on some *à priori* test, by which the degree of sufficient fluidity might have been determined. On this subject a good deal might be said, relative to the temperature of maximum fluidity of the speculum alloy; but it is not necessary to raise that question for my present purpose, which is simply to show that Professor Potter's demonstration is incomplete.

The condition assumed is, that a bubble of air becoming entangled in the fluid metal, its very small specific gravity will allow of its being

ejected vertically by the hydrostatic pressure to which it is subjected. Now, looking at the conditions a little more closely, it does not appear that this ought to follow at all as a matter of course. The air, at the instant of entanglement, has comparatively a low temperature, and a proportionally high density; but when brought into contact with the melted metal, the temperature is correspondingly increased, and the volume expands, though not necessarily, in the direct ratio of the increase of the temperature. But in expanding, the capacity for heat is proportionally augmented, and the heat, which thereby becomes latent, can be derived only from the metal in which it is embedded. The consequence of this absorption of heat is obviously to cool down the film of metal, *b a c*, in contact with the air, it may be sufficiently far to render it solid, and thereby to enclose the air in a metallic vesicle, connected with the general mass, by other concentric strata of decreasing degrees of viscidity, from the solid to the condition of normal fluidity, in which the general body of metal then exists. If the general temperature be sufficiently high, and sufficiently long maintained, it is indeed to be expected that it will, in process of time, become uniform, and that, on this supposition, the vesicle will be released, and subsequently ejected. It is quite probable that this result is in part realized by the ordinary modes of procedure, and that it might be still more fully realized by adopting precautions calculated to insure it. Accordingly, I do not contend that all the air entrapped remains in the metal, but simply, that portions of it do remain in defiance of the law of fluid pressures.

According to the hypothesis, that some portion of the surrounding metal is cooled down by the expansion of the air-bubble which it encloses, it becomes immediately obvious that air-cells in abundance may remain, unless the temperature be not only very high, but sufficiently long maintained, to re-establish fluidity generally throughout the mass. And again, it is hardly less clear, that unless the fluidity shall have been carried so far as to render the atomic mobility of the metal approximately perfect, the same result must, to some extent, ensue, independently altogether of the hypothesis of the solidification of the surrounding vesicle of metal, by expansion of the air contained in it. In fact, the law of fluid pressures can and does apply only within the limits of fluidity; and there is perhaps no liquid, much less a mass of melted speculum metal, that can be named, to which it is applicable in the mathematical sense presumed by Professor Potter. It is indeed rendered more than doubtful, by some of M. Regnault's late experiments, whether there is even any gas to which the character of perfect fluidity can be assigned with mathematical strictness.

With regard, also, to the effect of fluidity on the solidity of the casting, perhaps Professor Potter requires to be informed, that certain of the metals, and copper especially, imbibe gaseous matter in proportion to their temperature, and only part with it in proportion as the temperature descends. To prevent the effects of this *principle*, it is often necessary to regulate the temperature of the melted metal with great precision when intended for casting. In the case of pure silver and copper, intended to be drawn into wire, this is particularly remarkable; if the metals have been raised beyond the proper temperature peculiar to each, air-cells are formed, and these in the process of drawing are ruptured, and render the wire luminous. Speculum metal may not possess this absorptive faculty—I am not aware that it does; still the negative ought to be established, before dogmatically asserting that an increase of temperature would have sufficiently met the difficulty in the particular case to which Professor Potter's remarks have reference.

There is another consideration which seems to be altogether overlooked by Professor Potter,—I mean the adhesive affinity of air for other forms of matter, with which it is in contact, and for which we have as yet no measure. We, however, know that the force, in whatever it may consist, is very great; so great indeed, as to offer almost inconceivable difficulty in the execution of experiments, which would otherwise be simple enough. One of the most familiar of these, is the apparently easy problem of filling a barometer-tube with mercury; the difficulty consists in freeing the metal of bubbles of air which adhere to the glass, and every person who has made the trial will know, that there are other laws to be respected than the law of fluid pressures.

The fact of the adhesion of air to solid surfaces—I might indeed say to surfaces generally,—contains in itself a sufficient explanation of the *impossibility* which Professor Potter finds in the supposition of air becoming entangled at all in the way supposed. He informs us, that "all fluids in contact, which do not mix, arrange themselves in descending orders, according to their greater specific gravities;" consequently, "it is impossible to see how air could place itself below *fluid* metal: and we must conclude, that the presence of cavities on the face of his (Lord Rosse's) castings, indicate that his lordship's metal was then deficient in fluidity, and flowing unequally over the chilling surface, or becoming too quickly solidified, contained the cavities which were found."

Without adverting to the dogmatism exhibited in this conclusion, I may briefly observe, that the experiment can be simply made in a way sufficiently satisfactory to show, that the corollary is subject to the same kind of modification as the main proposition: the fluidity is not, and cannot be perfect, and the adhesion of the air to the surface of the chilling base—rather, we may suppose, in the minute cavities of the surface—is very great; the adjustment of the fluids according to their specific gravities, must therefore be modified to a proportionate extent by the new conditions introduced. Pour a quantity of liquid—a quantity of mercury, for example—into a glass vessel, and observe whether all the air has been expelled from under it; whether the fluids have arranged themselves according to their respective gravities, in the mathematical and absolute sense assumed by Professor Potter. I have just made the observation on a glass bottle containing a few pounds of mercury, and I can assure those whom it may concern, that there are abundance of air-bubbles entangled between the metal and the base on which it rests. In this case it cannot be urged that the fluid metal has not had time sufficient to expel the air; it has had at least some weeks, and globules are still *very* numerous.

From this fact alone, independently of all others, it does not seem quite so futile as Professor Potter would have us to suppose, to provide a way of escape downwards for the entangled air. It is easy to suppose, and in fact is every day verified by experience, that entrapped air will be expelled downwards by the superincumbent weight, when that direction of escape is open to it; and should the mere weight of the metal not be sufficient wholly to exclude it from the mould, it will at least be generally found sufficient to prevent the formation of cells of any troublesome magnitude in the surface of the casting. In scarcely any instance will cells be found embedded within the metal, in consequence of bubbles of air being arrested in their ascent, by the increasing viscidity opposed to their upward motion, and the continually diminishing pressure by which they are impelled. The air will be expelled downwards, and the metal will settle conformably on the surface of the chilling base, considerably after the temperature has fallen below the point at which the law of hydrostatic pressures is superseded and overbalanced by the other forces in action, to maintain the stability of the cells, should such cells be actually formed.

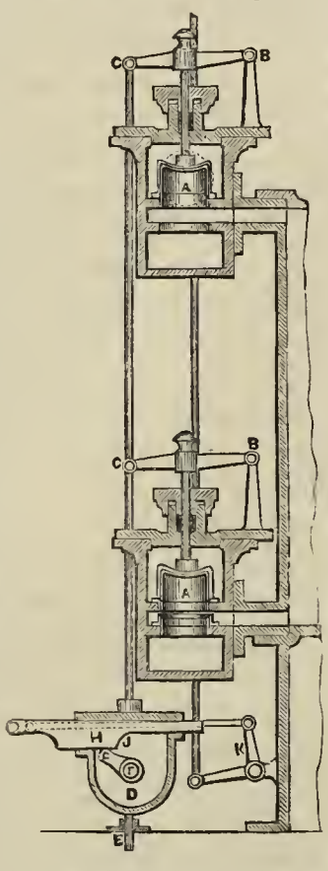
I need not pursue the subject further. I have said enough to satisfy those who have a very little experience in those matters, that there is really, in reason, some use after all in providing a mode of escape for the air downwards; that any such provision is neither futile nor unphilosophical, and that the law of fluid pressures is not the only law which it is necessary to consider in chill-casting. In the present state of our knowledge of the molecular forces of matter, the subject admits of much speculative reasoning. I have not attempted to open up the question even to the extent of the knowledge we do possess on some of the points incidentally adverted to. I am satisfied with showing that Professor Potter has taken much too limited a view of the data; that his reasoning is partial, and his conclusion false, both in fact and theory. I might, indeed, have taken quite other and lower ground than I have assumed to establish these positions; I might have appealed dogmatically to experience, as he has done to a mathematical principle; but it is always satisfactory to be able to render a reason for any technical process which appears to contradict an assumed principle of philosophy. I am besides not satisfied, that practice always so closely coincides with theory as it ought to do. Practice may err—theory never errs. But the difficulty consists in knowing what is the theory, when it is complete, what are all the data, and what their relations and numerical values under all circumstances. It is not enough to assume, with Professor Potter, that the whole theory is expressed by an isolated proposition, constructed on postulata, which, however admissible in purely mathematical reasoning, have only an approximate signification in physics. We have not, indeed, in physics any example of the exclusive action of a single law; all are compounded, and all conduce to effects which may be regarded as resultants of the individual forces, taken according to the mathematical significations attached to them in the class of elementary treatises, from which that kind of inspiration exhibited by Professor Potter is usually derived. There is not, indeed, a more common error committed by educated minds, than that of confounding mathematical with physical laws; in many minds of a high order, the hypothesis very speedily assumes the character of a fact; and it requires, indeed, very clear perceptive powers to maintain the distinction in the mind, though a wide, discontinuous, and discursive use of the modes of expression, to which the hypothetical reasoning gives currency and sanction.

I ought, perhaps, in the words of Professor Potter, to apologise for writing so much in detail on such a subject. "My apology is, that I am well aware the number of amateur telescope-makers in this country is much greater than generally imagined; and one who immediately

(criticises) published discoveries for the benefit of amateurs, ought to caution them against useless and unphilosophical methods." It is certainly very convenient to find an apology so exactly suitable ready-made to one's hand: I am obliged to Professor Potter for its use, and thank him accordingly. W. M. B.

ROWAN'S FLUCTUATING SLIDER FOR STEAM-ENGINE VALVE-GEAR.

The "fluctuating slider" is the name given by the inventors, Messrs. J. Rowan and Sons of Belfast, to an elegant and effective arrangement of self-adjusting valve-gear in connection with the governor. Our engraving is from a drawing of a vertical section of a pair of double-beat valves of a steam-engine, as fitted with the new slider, showing the governor connections. A A, Are the two steam-valves for the top and bottom cylinder parts. They are each worked by a horizontal lever vibrating on a fixed centre at B, and connected midway with the valve-spindles, being jointed at C C to a vertical valve-rod passing downwards to an eye in the top of the slider-frame, D, below. This frame is fast upon the end of the valve-rod, and moves with it, being guided vertically by a bottom spindle, E. A revolving shaft, F, projects into the hollow of the frame, carrying a cam or wiper, G, which, in its revolution, acts upon the under surface of the slider, H, and through it elevating the frame, the rod of which raises the valves. It is then evident that, by drawing the slider, H, horizontally back or forward in its guide in the top of the frame, the cam, G, will, in its revolution, approach sooner or later to the angle at J, where it ceases to act in keeping up the slider.



The length of time the valve remains open, and consequently the amount of steam admitted to the cylinder, is easily adapted to the load upon the engine, by connecting the slider to the governor. In the present case, this is accomplished by a vertical rod jointed at its lower end to a bell-crank at K, the opposite arm of which is linked to the slider. If a portion of the load is suddenly thrown off the engine, the increased expansion of the balls of the governor at once pushes back the slider, to bring its time of release earlier on in the revolution of the cam, and, of course, the opposite effect takes place when the governor collapses.

At the works of Messrs. Dunbar, M'Master, & Co., at Gilford, where the slider is in use on two forty-horse engines, the saving in fuel, consequent upon the adoption of this arrangement of expansion balance-valves, is stated to be fourteen tons per week. The contrivance certainly offers considerable advantages as a simple automatic regulator.

HYGROMETRY.

A great advance was made in the investigation of meteorological phenomena, by the invention of an accurate mode of ascertaining the humidity of the air. The atmosphere, even in its driest state, contains moisture; and it is a problem of high importance to find the quantity of that moisture.

Many substances possess the property of readily absorbing moisture whenever they are exposed to a damp medium; and several of them have been employed to discover the humidity of the air by exposing them to it for a short time, and then ascertaining the increase of their weight or dimensions. Instruments were invented by De Luc and Saussure, in which a slice of whalebone and a hair were used; but no ingenuity of detail was sufficient to overcome the rudeness of their principle. Another mode was therefore adopted to attain the end in view.

The conversion of water into vapour or steam, is accompanied, or rather preceded, by an absorption of caloric or heat. Evaporation, as that conversion is called, is consequently productive of cold in the body from which the absorbed heat is taken. Now it is well known that atmospheric air has a strong affinity for water in the state of vapour. It will absorb moisture, unless already saturated, whenever circumstances permit it to do so, even when the temperature is below the freezing point.

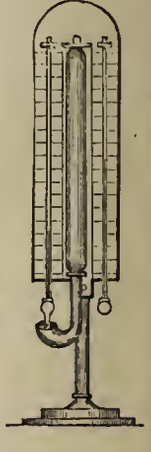
Experiment has demonstrated, that the higher the temperature the greater the amount of vapour it can hold in suspension. At the freezing point air will absorb $\frac{1}{160}$th of its own weight of moisture, but no more; at the temperature of 59° Fahr., the 80th part; at the temperature of 86°, the 40th part; at the temperature of 113°, the 20th part; at the temperature of 140°, the 10th part; the temperature advancing in arithmetical progression, and the absorbing power in geometrical progression. That is, these quantities of moisture will be taken up by perfectly dry air, and being then perfectly damp, if a further quantity is poured into it, that additional quantity will be deposited immediately.

Evaporation, we have said, produces cold. We may prove this by wetting the bulb of a thermometer exposed to the air, and a lower temperature will be indicated, as the moisture disappears, by a fall of the mercury. This is the effect of an abstraction, by the moisture, of caloric from the bulb, in order to its conversion into vapour, in which state alone it can satisfy the absorbent property of the air. It must be borne in mind, that the transfer to the moisture of heat, either from the bulb or from the air, as successive portions of it come into contact with the wet surface, is a process which necessarily accompanies or precedes the abstraction of moisture in the shape of vapour. Continuing to apply moisture to the bulb, we shall see it continue to fall down to a certain point at which it will stop, notwithstanding evaporation is made to proceed. The reason of this is, that after the bulb has been cooled, the air which comes to touch it must be cooled down to the same temperature, and thus each separate portion of air that successively encircles the humid surface, deposits that measure of heat on the chill-exhaling object, which is necessary to the conversion of the humidity into vapour, which heat the air again receives along with the humidity it dissolves. Hence the deposition of heat, and its abstraction by vaporization, very soon produce, by their alternate action, that precise degree of temperature at which each of these processes exactly balances the opposite effect of the other. When such an equilibrium has been brought about, the temperature will remain unaltered as long as the process continues, and thus the heat deposited by the air becomes an accurate measure of the heat spent in vaporizing the portion of moisture required for the saturation of the same air at its lowered temperature. Therefore, the dryness of the air is indicated by the depression of temperature experienced by a humid surface freely exposed to its action. In other words, the deposition of heat is in proportion to the diminution of temperature; and that diminution, therefore, is a measure of the heat abstracted, and of the dryness of the air, or its distance from saturation.

Setting out from the principles involved in the phenomena described, Professor Leslie applied the differential thermometer (see the article on the Thermometer) as a hygrometer (ὑγρος, wet, and μετρος, a measure), by covering one bulb with a piece of linen or porous paper, and applying moisture to it whenever it was desired to learn the state of the atmosphere. The instrument in this state was graduated with reference to the common thermometer. Evaporation commences on the application of moisture, and a fall of the liquid in the instrument takes place.

The instrument now commonly used as a hygrometer consists of two sensitive thermometers accurately adjusted to each other, and placed side by side. The bulb of one is covered with a piece of linen or silk, which is kept moistened by water supplied by a tube placed between the thermometers (see fig. 1). The degree to which the mercury falls will indicate the dew point; that is, the degree of temperature to which the atmosphere, where the experiment is conducted, must be reduced, in order that the vapour which it holds in solution should completely saturate it. The height of the thermometer at the dew point being compared with the height of the other thermometer, the degree of dryness of the atmosphere is ascertained, because we are thus made acquainted with the quantity of heat there is in it, over and above what is necessary to hold in solution its actual stock of moisture. Another form of hygrometer is that invented by Professor Daniell (see fig. 2). It is of glass, and the longer tube contains a small thermometer, the bulb of which is immersed in a quantity of ether held by the lower bulb of the external tube. In constructing the instrument, heat is applied to the ether in the bulb until its vapour has expelled all the air from the tube. It is then hermetically sealed, and the higher bulb covered with a piece of muslin. A small thermometer is attached to the stand supporting the whole. In using the instrument, ether is poured upon the covered bulb; its evaporation depresses the temperature, and the vapour in the interior

Fig. 1.



becomes rapidly condensed. As soon as condensation commences, evaporation begins at the surface of the ether in the lower hulh, and the temperature of that ether falls until a deposit of moisture from the external air is seen to form upon the outside of the glass. At this instant is noted the degree indicated by the enclosed thermometer as the temperature of the ether, and we thus obtain the dew point.*

Fig. 2.

When the dew point and the temperature of the atmosphere are known, the quantity of moisture in a cubic foot of the air, where the observations are made, may be found by the following formula, where t represents the temperature of the atmosphere, and p the elasticity of aqueous vapour at the dew point:—

$$\text{Weight in grains} = \frac{5656{\cdot}2}{448 + t} \times p$$

Dalton's table of the elastic force or tension of steam, will give the value of p for every degree of the thermometer. In this table, the elasticity is measured hy the height in inches of the column of mercury, which the vapour will support when the barometer stands at 30 inches. Dalton found that the elasticity of aqueous vapour suspended in air, is at its maximum for any given temperature when the air is saturated. When air, saturated with aqueous vapour, is diminished in volume, the elasticity of the vapour remains the same, since the ouly effect of compression is to convert the surplus portion into water.

"Temperature, atmospheric pressure, and the direction of the wind," says Humholdt, "have all a most iutimate relation to the atmospheric moisture so essential to orgauic life. The influence, however, of humidity on organic life is less,—a consequence of the quantity of vapour held in solution under different zones, than of the nature and frequency of the aqueous precipitations which refresh the ground in the form of dew, mist, rain, or snow. The agreeable and fresh verdure which many trees preserve in districts within the tropics, where, for from five to seven months, no cloud is seen on the vault of heaven, and no perceptible dew or rain falls, proves that their leaves are capable of drawing water from the atmosphere by a vital process of their own, which, perhaps, is not simply that of producing cold hy radiation."

As to the diurnal variation in the hygrometric state of the air, we are not yet in possession of many observed facts; but it would seem that the quantity of aqueous vapour in the atmosphere is least at sunrise, a little after the minimum of the diurnal temperature. In winter, the maximum quantity of aqueous vapour is found in the afternoon; and as the temperature falls, the vapour condenses upon all cold bodies. In summer, the quantity of vapour increases through the morning, but the maximum takes place before noon, earlier or later according to the month; then it diminishes through the afternoon, up to the time when the maximum of temperature occurs. From this time it again increases, and attains a second maximum about sunset. It then gradually diminishes to sunrise. At places near the sea, the quantity of aqueous vapour goes on increasing pretty regularly from sunrise iuto the afternoon, when the maximum occurs. In elevated situations, the increase of vapour in the daytime, and its diminution in the evening, are very rapid.

As to the annual variation in the hygrometric state of the atmosphere, it is in January that there is least moisture in the air. An increase takes place at first slowly, and then, in May and June, more rapidly. In July, the moisture is greatest, though, owing to the high temperature, the air is almost as dry as in August, in which month occurs the maximum of dryness. Then the quantity of vapour begins to decrease, and in January it attains its minimum.

With respect to the hygrometric conditions of different places on the earth's surface, it has been observed that the aqueous vapour diminishes in quantity as we leave the equator for either pole. Over the ocean the air is almost always nearly at its poiut of saturation; and as we advance into a continent, the quantity of suspended moisture diminishes. In the steppes of Russia, the plains of Orinoco, the interior of Australia, and the deserts of Africa, the air is extremely dry.

The density of moisture in the atmosphere diminishes with the height. On high mountains, during clear weather, there is great dryness in the air; but when they are enveloped in cloud, the air is more than saturated with moisture. During a residence of nine weeks on the Rigi, Kaemtz found that the air, on an average, contained 84·3 per cent. of the moisture necessary to saturate it, whilst at Zurich there was only 74·6 per cent. After eleven weeks of observation on the Faulhorn, the atmospheric moisture there, compared with that at Zurich, was found to bear the ratio of 74·4 to 74·8—that is to say, that the plain was as damp as the mountain. In 1833, a year in which much rain fell, the respective mean humidity of the two places was 85·5 (Faulhorn), and 75·3 (Zurich). These results show that the phenomena are connected with those of the decrease of temperature, which is more rapid in cloudy than in clear weather. "If there were never any rain, snow, or dew," says Sir John Herschel, "the aqueous atmosphere would be co-extensive with the aerial one, and each stratum of the latter in a state of exact saturation. Every act of precipitation unsettles this state of things, and withdraws from the total mass of the air some portion of its entire amount of vapour. As such precipitations, therefore, are constantly going on in some place or other, the atmosphere as a mass, though incumbent on a wet and evaporating surface, is necessarily always deficient in moisture. And for the same reason, every superior stratum is relatively deficient in comparison with that immediately beneath it from which its supply is derived. In point of ultimate causation, there is a constant drain upon the aqueous contents of the atmosphere, arising from changes of temperature. This drain extends to all its strata; but while the lower renew their losses from a surface hygrometrically wet, the upper draw their supply intermediately from sources more and more deficient in moisture."

Influence of Winds.—The north and north-east winds in Great Britain are well known to he dry, whilst the south and south-west winds bring moisture. The latter winds come to our island across a large expanse of ocean, from which they suck up much moisture; and, hesides, coming from warm regions, their absorbing powers are greater than winds from other quarters.

Dew.—When the temperature of the air falls by reason of the sun's declension, the air being no longer able to support the aqueous matter it absorbed during the heat of the day, deposits it again, in the shape of dew, upon cold objects at the surface of the earth. The greatest quantity of dew is deposited on calm and clear nights. Some bodies receive it in greater quantity than others. Thus, there is more laid down on grass than on the earth—upon loose sand than on solid ground—upon glass than upon metals; in short, there is more deposited upon bodies which rapidly loose heat by radiation than upon others. Dew falls all through the night. It is heaviest in places near the sea, and it is quite unknown in the deserts of Asia and Africa. When a body is hindered by any species of shelter from radiating heat freely, the quantity of dew deposited upon it is proportionably diminished; for the same reason, bodies, the surfaces of which are covered with small promineuces, are those upon which dew is most abundantly found, because they radiate most. Other things being the same, dew is most abundant when the air is humid. Wind hinders the formation of dew, hy continually bringing to bodies fresh supplies of warm air, and thus restoring to them the caloric, or a part of it, which they lost by radiation. Hoar-frost is nothing but congealed dew.

Fog and Mist.—When aqueous vapour condenses and becomes visible, it is termed fog or mist if near the earth, and cloud when at a certain elevation in the atmosphere. This condensed vapour is composed of a multitude of spherical particles of extreme minuteness. These particles are larger in winter than in summer. A fog will he formed when the air, charged with vapour, becomes colder than the ground. It is under these circumstances that we see mist over rivers and springs. When a column of aqueous vapour is seen over the volcano of Stromboli, the people are able to predict rain. In countries like England and Newfoundland, where the air is cold and humid in autumn, winter, and spring, whilst the sea is comparatively warm, in consequence of equatorial currents, the ground is frequently enveloped with thiek fogs. The collision of a cold wind with a warm one charged with vapour, will frequently cause a fog.

Clouds and Rain.—Our data with respect to clouds are very few. It is not accurately known what is the cause of a cloud's suspension in the air, but it has been conjectured that the particles of water composing them are visicular—that is, hollow. Those seen around mountains are frequently formed by the meeting of two winds at the summit. Those over plains are owing probably to a similar collision, or to the condensation of vapours, when they have attained to a cold and elevated region of the atmosphere.

Clouds have been classified according to their form. *Stratus*, a layer of cloud bounded by two horizontal lines. *Cumulus*, a cloud which takes a billowy rounded shape. *Cirrus* has a light filamentous composition, resembling feathers, or locks of hair, scattered on the blue vault. *Cirro-cumulus*, small rounded clouds that dapple the sky in close neighbourhood, and frequently placed in the zenith. *Cirro-stratus*, usually in the form of long horizontal streaks, or in short inclined streaks, but sometimes it is like a flattened cumulus. *Cumulo-stratus*, a cloud that combines the cumulus with one of the two last-named forms. *Nimbus*, a dense cloud, shaped like a cirrus at the top, and passing beneath into rain. Of all these, the cirrus is the cloud which soars the highest.

* See "Dry and Wet Bulb Thermometers," by James Glaisher, Esq., F.R.S.

Kaemtz estimates its average height at 21,300 feet. This cloud precedes changes of weather; in summer it announces rain, in winter a thaw or frost. The cumulus is frequently formed in a fine summer's morning; at first it rises, and then sinks in the afternoon, falling to the earth before sunset. This phenomenon may be often observed upon mountains; it is there owing to ascending currents of air which carry the vapour towards the upper regions. Clouds are formed by the precipitation of moisture under some of the following circumstances:—A diminution of the temperature of the air, unaccompanied by rarefaction or transportation—a diminution of temperature, occasioned by atmospheric rarefactiou, or by the transportation of air by wind from a warm to a cold climate—an intermixture of saturated air of different temperatures. Since the quantity of moisture which air is capable of holding in invisible suspension increases at a much faster rate than the temperature, it is a consequence of the mingling of two portions of air, both of them saturated but of different temperatures, that the mean temperature will not support as much moisture as the two when separate. Hence a deposit will ensue. If the aqueous particles are slowly formed, they will remain suspended in the shape of cloud. When the formation of the visible deposit is rapid and copious, the particles of moisture unite and fall to the earth in the form of rain, hail, or snow, according to the temperature of the air through which they fall. When the temperature of the air is at or below 32° Fahr., rain descends in the shape of snow; but the lower the temperature the less abundant is the fall, because there is less moisture in the air. Snow is formed by the quiet crystallization of the drops. The crystals are of various shapes, but they have all been found related to about five types. The most beautiful crystals are formed during the calmest weather. Sometimes, when the air is perfectly still, small frozen particles may be seen floating in it.

The depth of rain falling at any given place is measured by a simple instrument, of tin or copper, called the ombrometer, pluviometer, or rain-guage (fig. 3). At the upper end is a circular funnel, open both at the top and bottom. A graduated rod, with a piston attached to its lower end, passes through the bottom of the funnel into the cylinder below. The piston is so constructed that it floats on the surface of the water in the cylinder; and, of course, the rod rises as water enters the fuunel, and fills the cylinder.

Fig. 3.

Rain has been observed to fall from a clear sky. In this case the vapour has become condensed without taking the shape of clond. The quantity of rain which falls at one time is often very considerable, particularly within the tropics. In northern latitudes rain falls less plentifully; but even there, enormous precipitations of moisture occasionally take place within a few hours. A fall of 25 inches within twenty-four hours, bas been recorded at Sydney, New South Wales.

Rain in Tropical Regions.—Over the ocean where the trade-winds blow, the sky is always clear; but in the region of calms there is frequent rain. Iceland, where the trade-winds blow less regularly, there are two seasons—the dry and the rainy. Hence the quantities of rain which fall in different months are very unequal. At Bombay, the mean monthly depths for June is 24 inches, and for October only ·26 inches. According to Humboldt, the phenomena in that part of South America which is north of the equator occur in this order:—The sky is clear and the air dry from December to March, and the plants lose their leaves. The winds are from the east and the east-north-east. Towards the end of March the sky is less clear, and the hygrometer announces more humidity in the air; the trees begin to hud; a light fog sometimes veils the sun; the periodical wind blows gently, with frequent interruptions; large clouds, like mountains, accumulate in the south-south-west; frequent storms come from the south; the quantity of atmospheric electricity increases, especially at sun-down; and the rainy season sets in towards the end of April. The sky is hidden by grey clouds; there are storms every evening; and soon, when the sun is in the zenith, they begin in a morning.

The air is so damp in the rainy season that the dress becomes full of moisture. This is the time for fevers and endemic maladies. The rainy season coincides for these countries with the presence of the sun at the zenith. In Africa, near the equator, it begins in April; ten degrees to the north, on the banks of the Senegal, it begins in June and lasts to September. At Panama, on the American continent, the rains begin at the beginning of March; at St. Velas, in California, in the middle of June. On the western side of Hindostan, the rainy season takes place during the monsoon from the south-west; on the eastern side, during that from the north-east. The vapours pushed along by these winds condense on the summit of the Ghauts, and fall in the state of rain. On the coast of Malabar, the mean annual depth of rain is 123·5 inches. In the neighbourhood of Lima no rain falls at all, because the prevailing winds, blowing from the south and south-west, come from a colder to a warmer climate. Hence the air is always able to hold suspended the moisture they bring along with them. But during winter the ground is covered with thick fogs.

Rain in Lower Latitudes.—In proportion as we travel away from the equator, the regular alternation of a rainy and a dry season disappears. Thus, in the latitude of Madeira, rain falls at all times of the year, and more abundantly in winter than in summer, the contrary being the case between the tropics.

Rainy Winds of Europe.—Under this point of view we may distinguish three climates in Europe:—1. That of England and the western part of France, which extends a considerable distance into the interior of the continent. 2. That of Sweden and Finland. 3. That of the northern coasts of the Mediterranean. In that portion of Europe which lies to the north of the Alps and the Pyrenees, the south-west winds are charged with moisture taken from the sea, and when they arrive at colder latitudes the moisture is precipitated. In Scandinavia it rains through whole days. Over the whole extent of the Norwegian coast, the south wind unceasingly accumulate the clouds, which are stopped by the crest of the Scandinavian Alps. During this time the weather in Sweden continues fine, with the exception of slight falls of rain now and then. Rain is brought to this country by the east winds, that bring moisture from the Baltic and the Gulf of Bothnia. At St. Petersburgh, every wind brings rain.

Quantity of Rain in Different Seasons.—Rain falls in less quantity as we leave the sea-coast for the interior of a country. If we represent by 100 the total quantity of rain that falls in the course of the year at each of the places in the following table, then the numbers under the names of the seasons will represent the quantities that fall in each season:—

	Winter.	Spring.	Summer.	Autumn.
Eagland (eastern coast),	26·4	19·7	23·0	30·9
England (interior),	23·0	20·6	26·0	30·4
France (eastern part),	23·4	18·3	25·1	33·3
France (western part),	19·5	23·4	29·8	27·3
Germany,	18·2	21·6	37·1	23·2
St. Petersburg,	13·6	19·4	36·5	30·5

Miscellaneous.—Bergen, in Norway, is perhaps the wettest place in Europe: 89 inches of rain fall there annually. Keswick in Cumberland, and Kendal in Westmorland, have the reputation of being the wettest places in England—67·5 inches and 53·8 inches are the respective depths of the annual fall, whilst at London it is only 24·8 inches.

Observations seem to establish this rule—that the quantity of rain deposited at the surface of the ground, is greater than at an elevation in the air at the same locality.

The mean annual evaporation of water in Great Britain is ·0000456 inches, or ·01155 grains per minute.

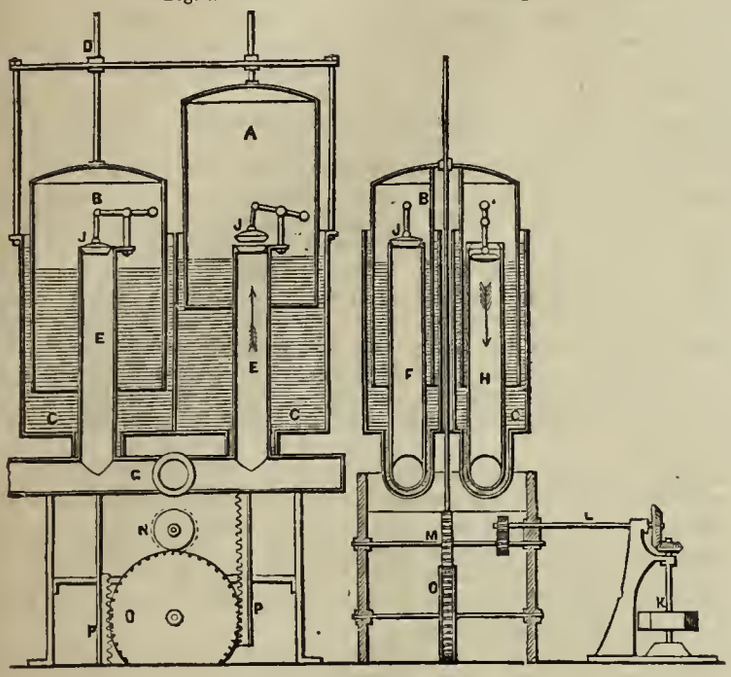
BLAIR'S PNEUMATIC GAS-EXHAUSTER.

Lately, when at Johnstone, we saw, at the gas-works there, a neat arrangement of a pneumatic gas-exhauster, worked, after a novel fashion, by the chimney draught, without any assisting mechanical power. The apparatus may be likened to a miniature double gasometer, the exhausting receivers or cases being worked alternately by a mangle-wheel in connection with a rotatory air or vane wheel. Fig. 1. exhibits a front sectional elevation of the exhauster, and fig. 2 is a corresponding section at right angles. A n, Are the two exhausting vessels, dipping into water chambers, C C, and guided vertically in their traverse by spindles on their top, at D D. E F, Are two gas supply pipes, in communication, through the horizontal pipe, G, with the line leading from the retorts. The route of the gas, on entering, is indicated by the arrows pointing upwards. Each exhaust vessel has, in addition to the two supply pipes, E F, two corresponding discharge pipes placed behind, one being seen at H, in fig. 2. Each inlet pipe has, upon its top, a clack valve, J J, with a balanced lever, opening upwards, and the discharge pipes have similar valves, opening downwards; so that, in the ascent of the exhausters, the inlets open to allow the gas to flow into them, as at J, in fig. 1, the corresponding outlet being closed by the same action; and in the descent the reverse takes place, the supply being cut off, whilst that already in the exhauster is discharged, as at H, in fig. 2.

In all previous exhausters, considerable mechanical power is employed in giving motion to the apparatus, but, in the present case, all the power required is obtained from a small air-wheel, K, which is placed horizontally in an air-duct, opening from the external air into the annular space of the chimney of the works. The upper side of this wheel being open to the atmosphere, the rarefaction of the air-column in the space

between the outer and inner chimneys, causes a rush of the cold air, which passes into the duct through the opening in the centre of the wheel, as shown by the arrows. The periphery of the wheel is fitted pretty close to the circular opening, so that the air only finds admission by the central aperture—rushing out by passages at the periphery, the reaction giving the rotatory movement. The power derived in this

Fig. 1. Fig. 2.



Three-eighths of an inch = 1 foot.

manner is communicated, by a pair of bevel-wheels, to the short horizontal shaft, L, carrying a spur-pinion, working into a corresponding wheel on the shaft, M. This shaft, again, carries a wheel, N, driving the mangle-wheel, O, which gives an alternate reciprocating movement to the two exhaust vessels by the toothed racks, P P. Working at the rate of three double strokes per minute, this exhauster passes through it from 1,000 to 1,200 feet of gas per hour, which latter quantity is the extent of the production of the works.

When we visited the works, the machine was performing its office with perfect regularity and noiselessness, and we were assured by the inventor, Mr. Blair, the manager of the works, that it had done so since November, 1848. Of course, the mode of driving here adopted is not universally applicable, inasmuch as it is presumed that if the gas has to be forced through a considerable depth of water, the air-draught will be wanting in power; but if the depth of water in the purifiers is not more than five or six inches, the arrangement we have shown will answer well.

IRON FOR RAILWAY STRUCTURES.

REPORT OF THE COMMISSIONERS APPOINTED TO INQUIRE INTO THE APPLICATION OF IRON TO RAILWAY STRUCTURES.

When, in 1847, the destruction of the Dee iron bridge gave occasion for the expression of the opinions of experienced men on the subject of the employment of iron for bridges and general railway works, these opinions proved, in several instances, to be so excessively contradictory, that Mr. Strutt, the President of the Railway Commission, felt it his duty to recommend the appointment of a distinct commission of inquiry as the only means of setting the unaccountable conflictions at rest. A royal commission, as previously adverted to in our report of Professor Willis's Birmingham address, was accordingly issued shortly after the accident in question, appointing Lord Wrottesley, Professor Willis, Captain James, Mr. G. Rennie, Mr. W. Cubitt, and Mr. E. Hodgkinson, as commissioners, with Lieut. D. Galton their secretary. In our notes of Professor Willis's detail of the experiments, at p. 183, *ante*, we gave some information as to the general result of the inquiry, and we now add the report itself in full:—

From the information supplied to us, it appears that the proportions and forms at present employed for iron structures, have been generally derived from numerous and careful experiments, made by subjecting bars of wrought or cast-iron of different forms to the action of weights, and thence determining, by theory and calculation, such principles and rules as would enable these results to be extended and applied to such larger structures and loads as are required in practice. But the experiments were made by dead pressure, and only apply, therefore, to the action of weights at rest. On the contrary, from the nature of the railway system, the structures employed therein are necessarily exposed to concussions, vibrations, torsions, and momentary pressures of enormous magnitude, produced by the rapid and repeated passage of heavy trains.'

These disturbing causes, in smaller degree, have always occurred in structures connected with mill-work or other mechanism. But the effects upon their stability have not been found greater than could be met by increasing the dimensions of the parts, without especially inquiring into the exact principles upon which such increase should be made. Thus, we are informed that the dimensions of cast-iron girders, intended for sustaining stationary loads, such as water-tanks and floors, are usually so proportioned, that their breaking-weight shall be three times as great as the load they are expected to carry, or in some cases four or five times as great. But when the girders are intended for railway bridges, and, therefore, subject to much concussion and vibration, greater strength is given to them by altering the above proportions, and making the breaking-weight from six to ten times as great as the load, according to the practice of different engineers. On the other hand, some consider that one-third of the breaking-weight is as safe a load in the latter case as in the former.

As it soon appeared, in the course of our inquiry, that the effects of heavy bodies moving with great velocity upon structures had never been made the subject of direct scientific investigation, and as it also appeared, that, in the opinion of practical and scientific engineers, such an inquiry was highly desirable, our attention was early directed to the devising of experiments for the purpose of elucidating this matter.

The questions to be examined may be arranged under two heads, namely,—

1. Whether the substance of metal, which has been exposed for a long period to percussions and vibrations, undergoes any change in the arrangement of its particles, by which it becomes weakened?

2. What are the mechanical effects of percussions, and of the passage of heavy bodies, in deflecting and fracturing the bars and beams upon which they are made to act?

A great difference of opinion exists among practical men with respect to the first of these questions. Many curious facts have been elicited by us in evidence, which show that pieces of wrought-iron which have been exposed to vibration, such as the axles of railway carriages, the chains of cranes, &c., employed in raising heavy weights, frequently break after long use, and exhibit a peculiar crystalline fracture and loss of tenacity, which is considered by some engineers to be the result of a gradual change produced in the internal structure of the metal by the vibrations. In confirmation of this, various facts are adduced, as, for instance, that if a piece of good fibrous iron have the thread of a screw cut upon one end of it by the usual process of tapping, which is always accompanied by much vibratory action, and if the bar be then broken across, it will be found that the tapped part is a good deal more crystalline than the other portion of the bar. Others contend that this peculiar structure is the result of an original fault in the process of manufacture, and deny this effect of vibration altogether; whilst some allege that the crystalline structure can be imparted to fibrous iron in various ways, as by repeatedly heating a bar red-hot, and plunging it into cold water, or by continually hammering it, when cold, for half an hour or more.

Mr. Brunel, however, thinks the various appearances of the fracture depend much upon the mode in which the iron is broken. The same piece of iron may be made to exhibit a fibrous fracture when broken by a slow heavy blow, and a crystalline fracture when broken by a sharp short blow. Temperature alone has also a decided effect upon the fracture; iron broken in a cold state shows a more crystalline fracture than the same iron warmed a little.

The same effects are by some supposed to be extended to cast-iron.

We have endeavoured to examine this question experimentally in various ways.

A bar of cast-iron, 3 inches square, was placed on supports about 14 feet asunder. A heavy ball was suspended by a wire 18 feet long, from the roof, so as to touch the centre of the side of the bar. By drawing this ball out of the vertical position at right angles to the length of the bar, in the manner of a pendulum, to any required distance, and suddenly releasing it, it could be made to strike a horizontal blow upon the bar, the magnitude of which could be adjusted at pleasure, either by varying the size of the ball, or the distance from which it was released. Various bars (some of smaller size than the above) were subjected, by means of this apparatus, to successions of blows, numbering in most cases as many as 4,000,—the magnitude of the blow in each set of experiments being

made greater or smaller as occasion required. The general result obtained was, that when the blow was powerful enough to bend the bars through one-half of their ultimate deflection (that is to say, the deflection which corresponds to their fracture by dead pressure), no bar was able to stand 4,000 of such blows in succession; but all the bars (when sound) resisted the effects of 4,000 blows, each bending them through one-third of their ultimate deflection.

Other cast-iron bars, of similar dimensions, were subjected to the action of a revolving cam, driven by a steam-engine. By this they were quietly depressed in the centre, and allowed to restore themselves, the process being continued to the extent even in some cases of 100,000 successive periodic depressions for each bar, and at a rate of about four per minute. Another contrivance was tried, by which the whole bar was also, during the depression, thrown into a violent tremor. The results of these experiments were, that when the depression was equal to one-third of the ultimate deflection, the bars were not weakened. This was ascertained by breaking them in the usual manner with stationary loads in the centre. When, however, the depressions produced by the machine were made equal to one-half of the ultimate deflection, the bars were actually broken by less than 900 depressions. This result corresponds with and confirms the former.

By other machinery, a weight equal to one-half of the breaking-weight was slowly and continually dragged backwards and forwards from one end to the other of a bar of similar dimensions to the above. A sound bar was not apparently weakened by 96,000 transits of the weight.

It may, on the whole, therefore be said, that as far as the effects of reiterated flexure are concerned, cast-iron beams should be so proportioned as scarcely to suffer a deflection of one-third of their ultimate deflection. And as it will presently appear, that the deflection produced by a given load, if laid on the beam at rest, is liable to be considerably increased by the effect of percussion, as well as by motion imparted to the load, it follows, that to allow the greatest load to be one-sixth of the breaking-weight is hardly a sufficient limit for safety, even upon the supposition that the beam is perfectly sound.

In wrought-iron bars no very perceptible effect was produced by 10,000 successive deflections by means of a revolving cam, each deflection being due to half the weight which, when applied statically, produced a large permanent flexure.

Under the second head, namely, the inquiry into the mechanical effects of percussions and moving weights, a great number of experiments have been made to illustrate the impact of heavy bodies on beams. From these it appears that bars of cast-iron, of the same length and weight, struck horizontally by the same ball (by means of the apparatus above described for long-continued impact), offer the same resistance to impact, whatever be the form of their transverse section, provided the sectional area be the same. Thus a bar, 6 × 1½ inches in section, placed on supports about 14 feet asunder, required the same magnitude of blow to break it in the middle, whether it was struck on the broad side or the narrow one, and similar blows were required to break a bar of the same length, the section of which was a square of 3 inches, and therefore of the same sectional area and weight as the first.

Another course of experiments tried with the same apparatus showed, amongst other results, that the deflections of wrought-iron bars produced by the striking ball were nearly as the velocity of impact. The deflections in cast-iron are greater than in proportion to the velocity.

A set of experiments was undertaken to obtain the effects of additional loads spread uniformly over a beam, in increasing its power of bearing impacts from the same ball falling perpendicularly upon it. It was found that beams of cast-iron, loaded to a certain degree with weights spread over their whole length, and so attached to them as not to prevent the flexure of the bar, resisted greater impacts from the same body falling on them than when the beams were unloaded, in the ratio of two to one. The bars in this case were struck in the middle by the same ball falling vertically, through different heights, and the deflections were nearly as the velocity of impact.

We have also carried on a series of experiments to compare the mechanical effect produced by weights passing with more or less velocity over bridges, with their effect when placed at rest upon them. For this purpose, amongst other methods, an apparatus was constructed, by means of which a cart, loaded at pleasure with various weights, was allowed to run down an inclined plane. The iron bars which were the subject of the experiment were fixed horizontally at the bottom of the plane, in such a manner that the loaded cart would pass over them with the velocity acquired in its descent. Thus the effects of giving different velocities to the loaded cart, in depressing or fracturing the bars, could be observed and compared with the effects of the same loads placed at rest upon the bar.

This apparatus was on a sufficiently large scale to give a practical value to the results. The upper end of the inclined plane was nearly 40 feet above the horizontal portion, and a pair of rails, 3 feet asunder, were laid along its whole length for the guidance of the car, which was capable of being loaded to about 2 tons; the trial bars, 9 feet in length, were laid in continuation of this railway, at the horizontal part, and the inclined and horizontal portions of the railway were connected by a gentle curve. Contrivances were adapted to the trial bars, by means of which the deflections produced by the passage of the loaded car were registered. The velocity given to the car was also measured; but that velocity was, of course, limited by the height of the plane, and the greatest that could be obtained was 43 feet per second, or about 30 miles per hour.

A great number of experiments were tried with this apparatus, for the purpose of comparing the effects of different loads and velocities upon bars of various dimensions, and the general result obtained was, that the deflection produced by a load passing along the bar was greater than that which was produced by placing the same load at rest upon the middle of the bar, and that this deflection was increased when the velocity was increased. Thus, for example, when the carriage, loaded to 1,120 lbs., was placed at rest upon a pair of cast-iron bars, 9 feet long, 4 inches broad, and 1½ inch deep, it produced a deflection of $\frac{4}{10}$ths of an inch; but when the carriage was caused to pass over the bars at the rate of 10 miles an hour, the deflection was increased to $\frac{5}{10}$ths, and went on increasing as the velocity was increased, so that at 30 miles per hour the deflection became 1½ inch; that is, more than double the statical deflection.

Since the velocity so greatly increases the effect of a given load in deflecting the bars, it follows that a much less load will break the bar when it passes over it than when it is placed at rest upon it; and accordingly, in the example above selected, a weight of 4,150 lbs. is required to break the bars, if applied at rest upon their centres; but a weight of 1,778 lbs. is sufficient to produce fracture, if passed over them at the rate of 30 miles an hour.

It also appeared, that when motion was given to the load, the points of greatest deflection, and, still more, of the greatest strains, did not remain in the centre of the bars, but were removed nearer to the remote extremity of the bar. The bars, when broken by a travelling load, were always fractured at points beyond their centres, and often broken into four or five pieces, thus indicating the great and unusual strains they had been subjected to.

We have endeavoured to discover the laws which connect these results with each other and with practice; and for this purpose a smaller and more delicate apparatus was constructed to examine the phenomena in their simplest form—namely, in the case of a single weight traversing a light elastic bar. For the weight, in its passage along the bar, deflects it, and thus the path or trajectory of the centre of the weight, instead of being a horizontal straight line, as it would be if the bar were perfectly rigid, becomes a curve, the form of which depends upon the relation between the length, elasticity, and inertia of the bar, the magnitude of the weight, and the velocity imparted to it. If the form of this curve could be perfectly determined in all cases, the effects of travelling loads upon bars would be known; but, unfortunately, the problem in question is so intricate, that its complete mathematical solution appears to be beyond the present powers of analysis, except in the simplest and most elementary case—namely, in which the load is so arranged as to press upon the bar with one point of contact only, or, in other words, the load is considered as a heavy moving point. In practice, on the contrary, a single four-wheeled carriage touches each rail or girder in two points, and a six-wheeled engine, with its tender, has five or six points in contact on each side. This greatly complicates the problem.

The above smaller apparatus is so arranged as to comply with the simple condition, that the load shall press upon one point only of the bar, and is also furnished with a contrivance by which the effects of various proportions of the mass of the bar to that of the load can be examined. From the nature of the problems, it is convenient to consider, in the first place, the forms of the trajectories that are described, and the corresponding deflections of the bar, when the mass of the bar is exceedingly small compared with that of the load.

Having obtained these under different relations of the length of the bridge, its statical deflection, and the velocity of the passing load, we proceed to investigate, in addition, the effect which a greater proportional mass of the bar or bridge has upon the deflections. We have been greatly assisted in this research by a most elaborate and complete analytical investigation by George Stokes, Esq., Fellow of Pembroke College, Cambridge, undertaken at the request of one of the members of the Commission. Unfortunately, the extreme difficulty of the problem has rendered its solution unattainable, excepting in the cases in which the mass of the bridge is supposed to be exceedingly small compared

with that of the load; and in the opposite case, in which the mass of the load is supposed to be small compared with that of the bridge. The examples that occur in practice lie between these two extremes; for in the experiments of the Commission, performed at Portsmouth, with the inclined plane already described, the weight of the load was from three to ten times that of the bar; but this is a much greater proportion than that which occurs in bridges, partly on account of the necessity for employing in experiments very flexible bars, to render the changes of deflection sufficiently apparent, and partly on account of the great difference of length; for if bars bearing the same ratio of weight to that of the load were employed in experiment, the deflection would become so small as to be scarcely appreciable. This will readily be perceived when it is stated, that in a bridge of 33 feet long, a deflection not greater than one-fourth of an inch is usually allowed, which deflection is only $\frac{1}{1440}$th part of its length; whereas, in experiment, it is necessary to employ deflections of two or more inches. In actual bridges, of about 40 feet span, the weight of the engine and tender is very nearly the same as the weight of that half of the bridge over which it passes; and in large bridges, the weight of the load is much less than that of the bridge.

Mr. Stokes has shown, that when the inertia of the bridge is supposed to be small, the trajectories of the load, and the corresponding deflection of the bridge, depend upon a certain quantity, which he terms β. This quantity varies directly as the square of the length of the bar, and inversely as the product of the central statical deflection (namely, that which would be produced by the load set at rest on the centre of the bridge), and of the square of the velocity with which the load passes over the bridge. When β is small, the increase of deflection due to the velocity of the load becomes very great, so much so, that if β be equal to 1·3, the statical deflections are doubled, and are tripled when $\beta = 0{\cdot}8$; becoming still greater as lesser values of β are taken. On the contrary, greater values of β correspond to small deflections; and it has been shown by our researches, that in the cases of real bridges β is rarely less than 14, and is commonly very much greater; and that, consequently, the greatest increase of deflection from velocity would be, upon this theory, never greater than one-tenth, varying from that to one-hundredth, or less. As β varies directly as the square of the length of the bridge, it is plain that the 9-feet bars of the Portsmouth experiments will correspond to much less values of β than the 20 and 30-feet lengths of actual bridges; while the values of β in the former cases are still further diminished by the greater deflections necessarily employed in experiments, as above explained. It is thus shown, that the enormous increase of deflection produced by velocity in the Portsmouth experiments cannot occur in real bridges, since it appears that the phenomena in question are developed to a great extent when the magnitude of the structure is diminished. But these calculations are made upon the supposition, that the inertia of the bridge is very small; and experiments made with the small apparatus above-mentioned have shown, that while β is less than about unity, the inertia of the bridge tends to diminish the deflection; while, on the other hand, when β is greater than unity (including, of course, all practical cases), the inertia of the bridge tends to increase the deflections, obtained upon the above supposition. Lastly, the total increase of the statical deflection, when the inertia of the bridge is taken into account, will be found much greater for short bridges than for long bridges. Supposing, for example, the mass of the travelling load and of the bridge to be nearly equal, the increase of the statical deflection at the highest velocities for bridges of 20 feet in length, and of the ordinary degree of stiffness, may be more than one-half; whereas, for bridges of 40 feet in length, the increase will not be greater than one-seventh, and will rapidly diminish as greater lengths are taken. But as it has been shown that the increase *cæteris paribus* is diminished by increasing the stiffness of the bridge, we always have it in our power to reduce its amount within safe limits. Hence, in estimating the strength of a railway bridge, this increase of the statical deflection must be taken into account, by calculating it from the greatest load which is likely to pass over the bridge, and from the highest possible velocity. It must be remembered also, that this deflection is liable to be increased by jerks produced by the passage of the train over the joints of the rails.

[We shall give the conclusion of this Report in our next number.]

BROWNLEE'S SELF-REGULATING EXPANSION VALVE GEAR.

This neat contrivance is the invention of Mr. Brownlee, of Rock-villa, Port-Dundas, at whose saw-mills it is now in action, upon a small pair of upright direct-action engines, which give motion to the sawing and planing machinery of the works. Fig. 1, is an elevation of the eccentric, segmental lever, slide-valve, and governor connections; and fig. 2, is an enlarged section of the slide and expansion valves alone. The arrangement is an adaptation of the ordinary link to work in connection with the regulating action of the governor. In the elevation, the engine crank is on its top centre, the relative position of the expansion eccentric, A, being as represented—slightly past its highest point. The rod, B, of this eccentric, is jointed at C, to a sliding stud-piece on the segmental lever or link, working on an end-fixed centre at D, which is jointed at an intermediate point, E, with the expansion-valve spindle below. The link is, as usual, formed to a curve of the radius of the rod, B, and the point of its fixed centre is found by the intersection of two curves of the radius

Fig. 1.

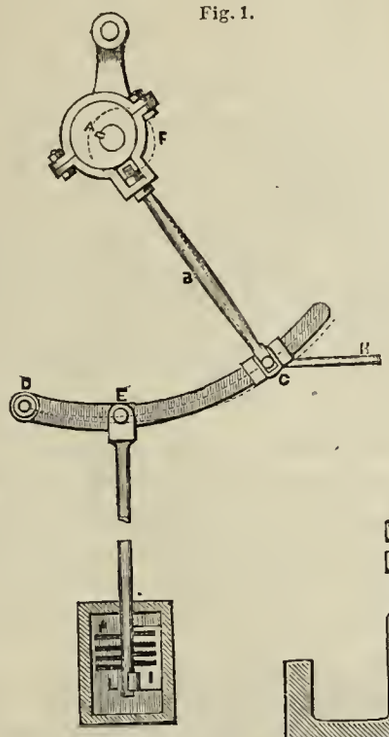
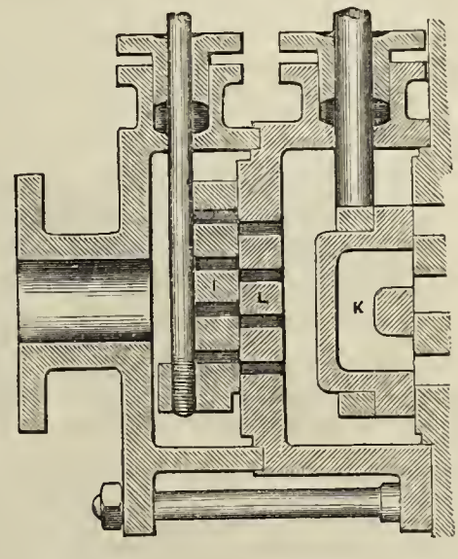


Fig. 2.



of this rod, the centres of which are taken at the two opposite positions of the eccentric. Thus the opposite position of the eccentric, A, is represented by the dotted circle, F, and a curve, struck from its centre, intersects the centre line of the lever at D, fixing the centre of oscillation.

The end of the governor link, H, is jointed to the sliding stud, C, which thus slides nearer to, or further from, the end of the link, accordingly as the governor expands or collapses with the varying speed of the engine; giving a shorter or longer travel to the expansion slide, I, below.

In fig. 2, the details of the valvular arrangement are shown by a section through the ports. The steam-slide is at K, working on the cylinder face in a steam-chest; the back of which, as at L, is formed with four narrow ports, corresponding to the same arrangement of ports in the cut-off slide, I, which works on the planed face of the back or partition piece, L. The steam slide, K, is worked by a separate eccentric, not shown in our figures; whilst the expansion slide is adjustable as we have explained, to cut off at any given point of the stroke, whilst the periods of steam inlet and exhaust are unaffected.

NOTES OF AN EYE-WITNESS ON THE BRITANNIA TUBULAR BRIDGE.

In venturing to give an outline of this novel and already celebrated work, our readers must not expect anything beyond a "plain unvarnished tale" on practical details, without any approach to a discussion of the scientific formula involved in its principles of construction, or calculations as to its stability; the necessity for entering upon such subjects being also less needful in this place, from the fact of Mr. Fairbairn having recently issued a beautiful and elaborate volume as a history of his experiments on Tubular Bridges, and Mr. Edwin Clark being about to publish a history of the Conway and Britannia Tubular Bridges.

From the time when the necessity of a speedy passage between London and Dublin was first felt, the Menai Straits and Conway River have been the chief engineering difficulties for the land portion of the journey between the two cities. These have been surmounted within the last thirty years by Telford, when he constructed the London and Holyhead turnpike road, by throwing across the Menai Straits the present suspension bridge, also the suspension bridge at Conway, for the Chester and Holyhead turnpike road. Both of these works have stood, unscathed,

the blasts of the hurricane, and the more continuous wear and tear of a heavy traffic—testifying to the wonderful ability with which they were designed and executed. But for the requirements of railway traffic, a more firm and unyielding form of platform was required, one having sufficient rigidity in all its parts to prevent the wave-like effect of a heavy load when passing over it; or, in other words, a platform that would not adapt itself to the position of the load. To effect this object, Mr. R. Stephenson, the Chester and Holyhead Railway Company's engineer, proposed a magnificent bridge of two arches, of 450 feet span, each having an approach viaduct, on the Anglesea side, of light Norman arches. These arches were proposed to be of cast-iron, and to rise 30 feet, the springing to be 70 feet above high-water level—the whole, by a contrivance peculiar to the design, to be built without centering; but this project did not satisfy the Lords of the Admiralty, who insisted upon their "pound of flesh," in the shape of a clear headway of 100 feet, for the whole breadth of the water-way, at high spring-tides. Mr. Stephenson being thus thrown back upon his own resources, after much consideration, hit upon the tubular scheme, the tube to be of a kind and shape to be decided upon by actual experiment. Having arrived thus far, he called in Mr. Fairbairn to aid in settling this most important point, and also the arrangement of details of construction. The success with which Mr. Stephenson has combated difficulties as they have arisen, and the courage with which he staked his reputation upon his accuracy and scientific skill, in approving or rejecting facts and theories as they presented themselves, are beyond all praise; nor can Mr. Fairbairn's name be forgotten while that of Stephenson shall be remembered, connected as they are with the important experiments which demonstrate the great fact, that wrought-iron beam bridges may be constructed to almost any extent.

The form of structure and site having been decided upon for the new bridge, the works were let and begun with all possible despatch; the successful competitors for the masonry were Messrs. Nowell, Hemingway, and Pearson, their tender being very considerably the lowest of any given in.

The contractors for the tubes were originally the Messrs. Garforth, Mr. Horton, Mr. T. Fairbairn, and Messrs. Ditchburn and Mare; but in consequence of after arrangements, Messrs. Garforth of Duckinfield undertook the construction of one large tube, and Mr. Mare of Blackwall undertook the building of the whole of the others, both large and small.

After several months spent in making preparations, which, for this work, required to be of the most extensive character, the first stone was laid on the 21st September, 1846, and the work, from that date, proceeded rapidly and prosperously to a completion; the top stone of the Britannia tower being fixed by Mr. Stephenson on the 22d of June, 1849, being at the rate of 3 cubic feet per minute from the time of setting the first stone, to the fixing of the top one, reckoning six days of 12 working hours to the week.

If, with this part of the subject, we remember the enormous quantity of stone used,—the difficulties and delays of getting in foundations—tide work,—the danger in navigating such troubled waters as the Menai Straits,—and the trouble in opening out new quarries, and having to instruct the workmen employed there in a new trade;—some idea may be formed of the difficulties which have been overcome in this department alone.

The situation selected for the site of the bridge is about three-quarters of a mile to the westward of Telford's Suspension Bridge, at a place where the channel is divided into two nearly equal streams by the Britannia Rock, the dreaded Swilly and Cribbinean Rocks lying between the two bridges. At spring-tides the water races past the Britannia at the rate of from seven to eight miles per hour, at which times it is with difficulty the ferry-boats for conveying the workmen across can ply; indeed, at these periods, crossing would be impracticable, if it were not for a species of dodging navigation amongst eddies and backwater, that to a stranger and looker-on is very amusing.

The ground on the Carnarvon side falls towards the Straits with a considerable slope, and stops against the stream with a perpendicular bank of 40 feet high, having a narrow strip of shaley beach at the bottom, on which stands the Carnarvon tower. The Britannia Rock, as before mentioned, is near the centre of the Straits, and is covered over its highest point with 3 feet of water at high spring-tides. The Anglesea shore rises with an uneven rocky slope from the water's edge, until, at a distance of some 600 yards, it attains an elevation of rather more than 300 feet.

The whole of the external masonry of the bridge is of Anglesea limestone, from quarries opened in Red Wharf bay for the supply of these works. The stone is generally sound and of excellent quality, and withstands a pressure of upwards of a ton per square inch before crushing. It also burns to a strong lime. It can be obtained in blocks of nearly any size as regards length and breadth, the practical limit being the expense of getting and removing stones of unusual dimensions. During the progress of the works, it was a very common occurrence to have stones upon the workground containing from 80 to 100 cubic feet, and others upwards of 20 feet long. The internal masonry is, for the greater part, of Runcorn sandstone; and, in some portions of the work—where it will allow of such being used—brickwork in cement is adopted.

The whole work is of the description termed ashlar, having the beds and joints accurately dressed. The external face of the work is left rough, as obtained from the quarry, and built to a regular batter of 3 inches horizontal to 10 feet vertical. The beds and joints are all pitched to a straight line, and the angles of the towers and abutments are defined, from bottom to top, by a six-inch marginal dressing, which completely obviates the objection of jagged irregular angles, which, with justice, is urged against the generality of quarry-faced work.

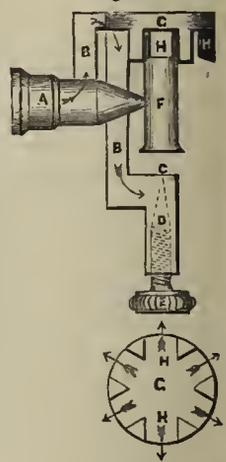
The string courses which cross the towers at the level of the top and bottom of the tube, are dressed fair with the tool, and so, likewise, are the plinths at the top of the towers, with the pilasters, architrave, and cornice of temper-finish, on the same. The porteullis ornaments on the sides of the towers are likewise tool-dressed; the frieze, cornice, and parapet of the abutment towers and wing walls, also the pedestals for the lions, are tool-dressed; the whole forming a very agreeable contrast to the rough varying face left upon the remainder of the work.*

LANGMAN AND WARD'S BURNER FOR SPIRIT LAMPS.

This is a recently registered invention, by Messrs. Langman and Ward of the Star Distillery, Wolverhampton, applicable to lamps constructed on the principle of Messrs. Holliday & Co.'s self-generating gas lamps, figured and described by us at p. 180, vol. i. of this Journal—the object being to burn the vapour of "luxurine"—styled by the inventors the "quintessence of light"—and naphtha. The liquid spirit, being vaporized by the heat of the burner itself, is mixed with atmospheric air, and burnt in the gaseous form.

Fig. 1 represents a side elevation of the burner, and fig. 2 a plan of the lower surface of the spreading disc, against which the flame impinges. The branch pipe, A, conducts the spirit from the reservoir, as indicated by the course of the arrows, and in passing along the channel, B B, it is vaporized by the heat of the flame, so that it issues in the form of a jet of vapour at C, by an aperture adjustable in size by the pointed steel screw, D, the head of which projects downwards at E. Immediately over this jet is a tube, F, up which the vapour passes, becoming commingled with air in the transit. It is then deflected by the top disc or plate, G, so as to issue out in a series of jets at H H, forming, when ignited, a star of light. The luxurine burns with a very brilliant white light, and is stated to have this advantage over ordinary naphtha, that it is not so inflammable; inasmuch as, if a lighted match is plunged into it, it will not inflame. It is also free from the unpleasant odour inseparable from naphtha. This is of importance, for the many serious accidents arising from the great inflammability of naphtha, leave us with some dread as to employing its brilliant light.

Fig. 1.



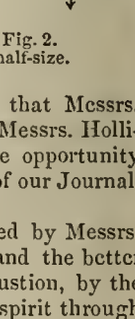


Fig. 2.
half-size.

As far as the burner itself is concerned, we are afraid that Messrs. Langman and Ward have been completely anticipated by Messrs. Holliday of Huddersfield, on which point our readers have the opportunity of satisfying themselves, by a reference to the earlier page of our Journal, already quoted.

The points of superiority over the older burner, claimed by Messrs. Langman & Co., are—the general shape of the burner, and the better commingling of the air with the vapour previous to combustion, by the adoption of a bell-mouthed air-tube; also, in passing the spirit through the flame without crossing the button at the top, which would make it too hot, causing a superfluous amount of pressure by the production of a larger quantity of vapour, tending to make the light noisy and unsteady; and lastly, in the formation of a tulip-shaped flame, by the angular inner edges of the division-pins in the top disc, the action of which is, to divide the flame into six horizontal hat-wings.

* We must extend these notes into our next number, when we shall furnish some illustrative sketches of details.—Ed. P. M. Jour.

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RECENT PATENTS.

PRINTING.—A. F. Rose, *Glasgow.—Enrolled January* 24, 1850.

Mr. Rose's invention refers to several heads of improvement in rotatory printing machines, and embraces certain arrangements whereby paper, in the state of a web or roll, is printed on both sides at one operation. The web of paper is, in the first place, conducted over the top of the printing cylinder, formed to hold the required amount of type on its whole circumference, receiving an impression on its under side from an upper impressing roller. It then passes round what the patentee terms a "reversing bar," or, it may be, a combination of rollers, which bar is set at an angle with the line of motion of the paper; and, being thus reversed, it receives its upper impression in a second machine, placed at an angle with the first. Each type cylinder has both an upper and lower impressing roller, so that the two combined are capable of printing two webs or sheets of paper, on both sides, at one time.

As a means of obtaining a correct register of the paper, or to secure the accurate agreement of the two impressions of a sheet, Mr. Rose shows a most ingenious plan for minutely increasing or diminishing the diameter of the type cylinders, by an endless elastic band, passing round the cylinder ends, and acted on by tension pulleys.

We append the claims:—

1. The combination of two letterpress printing machines, set angularly with respect to each other, forming a duplex machine for the purpose described.

2. The use or employment of reversing bars and rollers, separately, or in combination, for the purpose of reversing or turning the surface of the paper, for obtaining reverse or second impressions.

3. The use or employment of elastic bands, or fabrics, as a means of obtaining a correct register or agreement of the two printed surfaces in double-printed sheets of paper.

4. The system of obtaining a correct register of the two impressions of the paper, by means of an adjustment of the height of one or more of the blank spaces across the form of type in the cylinder.

5. The formation of one or both ends of the type cylinders with separate loose pieces combined to form one whole surface, so as to allow of putting in or taking out the separate columns of types.

6. The system of fastening types upon cylinders by means of wedge-shaped column rules, or division-pieces, placed between the different bodies of types, and arranged to approach to, or recede from, the centre of the cylinder, and, consequently, towards and from each other, so that each pair gives a parallel wedging action to compress the types laterally.

7. The use or application of radiated types upon cylinders of various diameters, by means of galleys with curved surfaces, as described.

8. The formation and use of type-cylinders, with a surface equal to the size of the required form of type, with angular surfaces, adapted for holding parallel types of the ordinary form, together with the general arrangement of these cylinders.

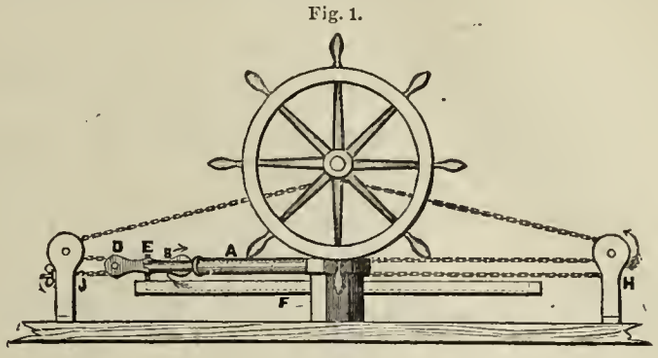
REGISTERED DESIGNS.

TELESCOPIC TILLER.

Registered for Mr. W. Simons, *Ship-Builder, Greenock.*

The main objects of this improvement, of which we give two views, in its application on board ship, are the prevention of the objectionable slackening of the wheel chain, together with the non-liability of riding, and the direct and complete communication of the movement of the wheel to the rudder, with increased power when the rudder is quartered. Fig. 1, of our engravings, represents a front elevation of the steering apparatus, and fig. 2 is a plan corresponding.

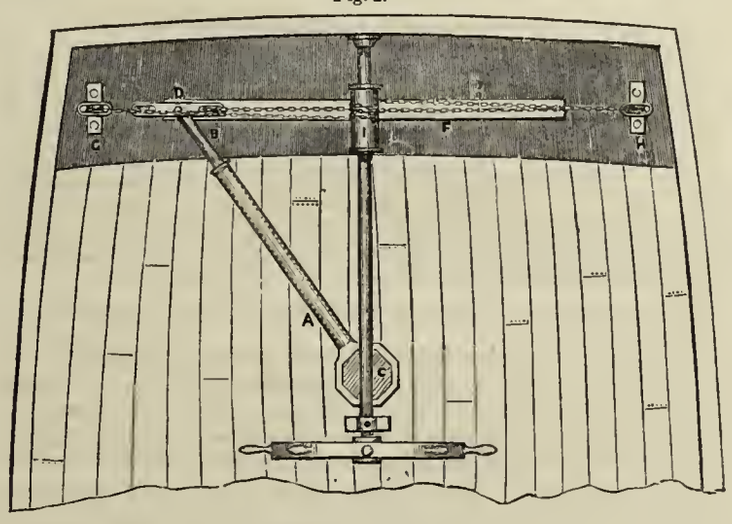
Fig. 1.



½ inch = 1 foot.

The tiller is formed in two detached pieces, A and B. The part, A, attached to the rudder-head, C, is tubular, as indicated by the dotted lines, being bored out to receive the solid lever or rod, B, the outer end of which is jointed to the tiller-block, D. The pin, E, forming this joint, projects through below the block into the horizontal grooved guide-piece, F, so that, in steering, the tiller-block, with the line of chain, is always caused

Fig. 2.



½ inch = 1 foot.

to travel in a perfectly straight line from side to side. G H, Are the usual standards for carrying the rudder-chain. One end of the chain is attached at H, to the standard, proceeding in the direction of the arrows, round one of the pulleys of the tiller-block, D, thence returning round the pulley in the top of the standard, H, from which point it is passed round the steering barrel, I, returning in the usual manner, on the opposite side, to the adjustable hook, J, in the standard, G. In the drawings, the rudder is represented as hard up; when moved back, the tiller-block traversing in a straight line, the lever or rod, B, works itself into the tube or telescopic piece, A, as it approaches midships, working out again as it passes to the opposite side.

The advantages of this elegant arrangement are at once apparent. The objectionable slackening of the chain, arising from the unavoidable curvilinear traverse of the end of the tiller, in the ordinary steering apparatus, is entirely removed by the simple telescopic action which Mr. Simons has so cleverly introduced; and at each change of movement of the wheel, the action of the steersman's hand is at once communicated to the rudder, without the loss occasioned by having first to "take up the slack." The slight addition of the adjustable hook, J, also admits of a ready means of tightening the chain at pleasure.

REVIEWS OF NEW BOOKS.

Multiplication Tablets: derived from a Theorem of S. Slonimski. The Tablet Arrangement, &c., by Henry Knight. Birmingham.

This is a small book, with large pretensions. Whether it shall henceforth be cited in evidence of the wisdom of the vernacular proverb, which sets forth that value is in the inverse ratio of bulk, we shall not venture

to predict. The onus of such a decision is greater than we choose voluntarily to assume. But we are not without confidence that the interested reader—and we hope all readers are becomingly interested—who will patiently bear us company in a topical survey of the new province, which, we are herein told, has been added to the domains of mathematical science by Mr. Slonimski's discovery, will have little difficulty in forming for himself a very precise judgment of the real value of Mr. Knight's performance, independently of any promptings from our pen.

Mr. Knight very properly reminds us at the outset, "that the operation of multiplication, particularly of large numbers, should be facilitated by the construction of tables exhibiting the proper figures;" but that "the apparently unlimited extent of tables necessary to provide for every contingency, has rendered it doubtful if advantage could be derived from the use of such tables." It now appears, however, that the "apprehended obstacle has been only imaginary," as is proved by the *tablets* now published on ten small pages of large type. These tablets, as intimated in the title, "are derived from a theorem of S. Slonimski, a distinguished mathematician of Bialystock, in Poland, developing a curious and important property of numbers, which appears to have escaped the notice of other mathematicians."

Although we are not of those who regard mathematics as a perfected science, we yet confess that serious doubts, whether anything relating to the simple multiplication of numbers, so very important as is here set forth, remained for Mr. Slonimski to discover. We remember that Legendre systematically surveyed the ground, and our misgivings increase. How far our scepticism is founded in reason must be determined from the theorem itself. We give it *in extenso*, as it is rendered by Mr. Knight:

"Let Z be any number whatever, and let the figures composing that number, in passing from the right hand to the left, be represented by z_1, z_2, z_3, ... z_ε . . . . If under the number Z be written its multiples 2Z, 3Z, 4Z, 5Z, 6Z, 7Z, 8Z, 9Z, in such order that the units, tens, hundreds, &c., appear in vertical lines, it is evident that the last vertical line, viz., that which appears under the last figure z_1, of the number Z, will contain the *second figures* of the products $2z_1$, $3z_1$, $4z_1$, $5z_1$, $6z_1$, $7z_1$, $8z_1$, and $9z_1$. But such will not be the case with respect to all the other vertical lines; that, for example, which is under z_ε, will not contain the series of *second figures* of the products $2z_\varepsilon$, $3z_\varepsilon$, $4z_\varepsilon$, $5z_\varepsilon$, $6z_\varepsilon$, $7z_\varepsilon$, $8z_\varepsilon$, $9z_\varepsilon$. To obtain the figures under this line, there requires to be added to the series of second figures of the multiples of z_ε, a COMPLEMENTARY SERIES, dependent on the figures which follow z_ε in the number Z. Now, whatever may be these last-mentioned figures, there exist but TWENTY-EIGHT DIFFERENT COMPLEMENTARY SERIES; and on adding to the series of *second figures* of the multiples of z_ε, that one of the twenty-eight complementary series which appertains to the figures which follow z_ε in Z, the figures in the vertical line z_ε will be obtained."

These twenty-eight different complementary series constitute Mr. Knight's ten tablets.

We have often heard of old friends with new faces, and Mr. Slonimski's theorem, after all, appears to be one of these. Stripped of its algebraical mask—which, by the way, seems to fit rather indifferently—it appears to amount to no more than the very elementary fact—long since degraded from the dignity of a theorem, though no doubt very unjustly—that in multiplying a given number by the digits of any other given number, the second figures of the digit-products ought successively to be added to those which immediately succeed them in the order of notation. In still more familiar phrase, we *set down the units and carry the tens*. This being done for all the figures of the multiplicand, and with every figure of the multiplier, we shall have obtained a series of partial products corresponding in number to the number of figures in the multiplier; and, to complete the theorem, these products must be so arranged that all the second figures of the digit-multiplications shall fall under the first of the next higher order. The units, tens, hundreds, ... will now appear in vertical lines conformably to Mr. Slonimski's theorem; and it only remains to find their sum by the ancient rule for addition, in order to have the complete product, unless, indeed, we take Mr. Knight's advice, and procure one of Mr. Slonimski's "instruments for effecting arithmetical computations" of the particular kind, by which "the operations of addition and subtraction are effected with admirable facility."

Such, then, is the nature of this "curious and important" theorem, which so long lay concealed among the arcana of mathematical science. But while we cannot agree with Mr. Knight in accrediting Mr. Slonimski with the happy discovery we are glad to have it in our power to allow the merit of having d ned the number of variations which the carriage-figures in a multiplication can effect on those of the succeeding orders. It is in this that Mr. Slonimski's discovery really consists, and it is worth explaining, independently altogether of the utility of Mr. Knight's tablets.

Supposing a clever schoolboy is required to multiply some large number by several given multipliers in succ , he will very soon discover that time and mental effort may be saved, and the chances of error reduced, by previously multiplying it by all the digits above 1, and forming the products into a table, from which he may adopt those corresponding to the figures of the particular multiplier with which he is to operate. The table which he thus forms is general for all multiplications of the given multiplicand, but it is useless for every other, even when the difference extends no further than the order of the digits. But let us suppose, farther, that in order to generalize this artifice, he transfers the digit-products of the ordinary multiplication table to a square of card paper, properly ruled into compartments to receive them; and that he divides this table vertically into parallel slips, having each one of the digit-numbers at top to designate its order. He will now be in possession of a moveable table, which he can arrange—in whole or in part—according to the order of the figures in the given multiplicand. The slips, whose leading figures thus correspond in degree and order with the given number, being so arranged, with an index-slip containing the simple digits placed on one side, to indicate the order of the divisions in the table, the process of multiplying is reduced to writing down the first figure on the right of each slip, increased by the second figure on that which precedes it. The mental effort is thus confined to the very easy business of successively adding together two digits of which the sum can never exceed 18.

It is this minimum of labour which Mr. Knight's tablets are intended to supersede. Mr. Slonimski perceived that all the cases of addition which could thus arise might be disposed in a series of ten tables, corresponding to the number of digits when the 0 is included; and that each of these tables would extend to only twenty-eight lines (of ten figures each, including the 0), answering to the number of unit-changes in the carriage-figures, resulting from the continued multiplication of 0, 1, 2, ... 9, by the digits of the series in the same order. Thus, in multiplying by 1, the highest digit gives 0 for carriage, and, accordingly, the first series of the fundamental tablet consists merely of ciphers. But in multiplying by 2, the digits 5, 6, 7, 8, 9, give each a carriage of 1, and, accordingly, the sixth series of the tablet is—

0 0 0 0 1 1 1 1 1

Again, in multiplying by 3, the digits 7, 8, 9, give each 2 of carriage, and 4, 5, 6, respectively give 1; hence, the ninth series is—

0 0 0 0 1 1 1 2 2 2

Similarly, the multiplication by 4 gives the thirteenth series—

0 0 0 1 1 2 2 3 3 3

And, finally, we obtain from 9 the highest carriage series—

0 0 1 2 3 4 5 6 7 8

which is the twenty-eighth in the order of succession adopted.

The cycle of series predicated by Mr. Slonimski being in this way completed, we obtain the first and fundamental one of Mr. Knight's tablets—that which is employed as the basis of the other nine. These are found by simply adding the unit-figures of the digit-products of the successive multiples of 0, 1, 2, ... 9, by all the individual digits from 1. Thus the multiple by 5 is—

0 5 10 15 20 25 30 35 40 45

And adding to the unit-figures of this series those of the thirteenth carriage series given above, we obtain, as the corresponding series of the tablet corresponding to the given multiplier 5—

0 5 0 6 1 7 2 8 3 8

In this manner the ten tablets are obtained; and it is abundantly evident from these explanations, combined with a modicum of reflection, that, as respects mere capability, they must possess all the potency which Mr. Knight has claimed for them. All multiplications of whole numbers—and all multiplications may be reduced to that of whole numbers—may be performed by their means. There is no case beyond their power. But in this estimate of capability we cannot, with Mr. Knight, include convenience, facility of operation, and exemption from risk of error. They seem to us to possess none of these advantages. It is true they give the figures required directly, and by simple inspection, but only on their being picked out individually, according to the order in which the digits stand in the given number. Constant reference is thus requisite to the top of the table, to make sure that the line corresponding to the figure in the multiplicand is taken; and, moreover, there will commonly be *one more than as many* changes from table to table, as there are figures in the given multiplier. Even the occurrence of a cipher in the multiplier affords no relief; it must have its significant representative line among the partial products, picked out figure by figure, like that of any other digit.

Such assistance appears to us back-weight—so much so, that we feel inclined to submit the case to Mr. Knight's own decision. Taking the example he has given of the use of the tablets, it appears to us that he could have found his partial products with more facility by 25 per cent. had he followed simply his old school-day rule. His multiplier is

5906637: with this he has had to pick out his figures *individually* from eight of his tabular series, and, besides, he has increased the additive part of the process by two lines—that is, from six to eight. The figures of the multiplier, moreover, present facilities for abridging the mental labour which he could not take advantage of by the tahular operation.

Whatever, therefore, may be the ingenuity of the tahlets, and the merit due to Mr. Slonimski for the discovery on which they are founded, we have no hesitation in expressing our unqualified opinion that they cannot, under any conceivable circumstances, be used with advantage for such purposes as Mr. Knight seems to have intended them. It is, however, only justice to Mr. Slonimski to state, that he does not appear to have proposed his theorem with any view to its being applied in the direct way propounded by his translator; it seems to have been intended merely as the basis on which "his very clever instrument for multiplication" was to rest. So applied, the tahlets may assume, for aught we may know, a very different value from that they appear to possess in the printed form. We must, however, state of Mr. Knight's performance, that what he has done is well done—the tablets are admirably printed, the typography is elegant, and the arrangement complete. We wish we could say more in their favour.

Britannia and Conway Tubular Bridges—Truths and Tubes on Self-Supporting Principles. By Thomas Fairbairn. Pp. 63. Longman & Co., London. 1850.

The unfortunate, and now notorious, misunderstanding between the two eminent engineers of this practical wonder of the nineteenth century—to which we owe the appearance of this book—must produce a strong feeling of regret in the minds of every one. "No really fine work of art," says Fuseli, "was ever produced but for its own sake;" and this, if true in *his* art, is equally so in the more lofty of the conceptions of ours. Engineering genius, whilst being heightened by an honourable emulation, must be untainted by jealousy. What a miserable subject have we for contemplation, in the fact that the most magnificent constructive work of the present age could not be completed without a positive squabble between the men, whose joint endeavours have thus earned for them undying fame!

The general statements of the case have long since been made public; and we have, ere this, ventured upon an opinion on its merits, in our notice of Mr. Fairbairn's valuable book, containing the pleadings on his side of the question.

We remarked at that time, that we might possibly have to recur to the subject in connection with Mr. Stephenson's rejoinder, and that we were not far wrong, has been evidenced by the subsequent appearance, in the *Quarterly Review*, of an article at once popularly descriptive of the Conway and Menai bridges, and an advocate of the views held by Mr. Stephenson, as to his sole and undivided ownership of the merit involved, as well in the conception of the idea, as in the execution of the details of the bridges. It is true that Mr. Stephenson has not personally ventured into the lists of literary warfare, but the separate republication of the anonymous article in the Review, under the avowed authorship of Sir Francis B. Head, tells us that Mr. Stephenson has by no means "suffered judgment to go by default," by the committal of his cause to so unscrupulous an advocate. As is justly remarked in the introduction to "Truths and Tubes," so long as the honourable author's very peculiar statements, circulated only in their anonymous form in the pages of a Review, it was unnecessary to attempt to disturb the impression they might produce; but when they reappeared under the singular title of "Highways and Dryways," with the bold appendage of the author's name, the necessity of publicly meeting the charges therein made out was distinctly obvious. As we shall hereafter see, this has been done, and done well, by Mr. Fairbairn's son, in the volume we now look over.

The extensive dissemination of the allegations in question, in their twofold shape, has made it needless for us to refer to them in detail—further than to state, that in the fifth chapter of this said "Highways and Dryways," purporting to consider what the author terms Mr. Fairbairn's claims, we are especially called to notice:—

"1st. An alleged inaccuracy, or rather wilful misrepresentation, on the part of Mr. Fairbairn, in describing, in his work, the original idea of a Tubular Bridge as conveyed to him by Mr. Stephenson.

"2d. The broad and positive assertion of the writer,—speaking here as throughout the pamphlet authoritatively the views of Mr. Stephenson,—that Mr. Fairbairn was not justified in taking to himself the title of Joint Engineer with Mr. Stephenson to the Bridges; and

"3d. A statement, to which particular prominence is given, that Mr. Fairbairn, whilst acting for the Company, *allotted to himself* a most lucrative contract in connection with the construction of the iron-work of the Bridges."

And it is with these several points before him, and in this sequence, that Mr. T. Fairbairn approaches his task.

To show the disingenuous use which Sir F. B. Head has made of the evidence given by Mr. Stephenson before the House of Commons' Committee, we have some twenty pages devoted to a joint exposition of the evidence as it was, and as it appeared after passing through his hands. It would be more than useless to dwell on this head—for no disinterested party, who reads the straightforward evidence, can for a moment doubt, that not only was Mr. Fairbairn professionally consulted by Mr. Stephenson, long before the obtainment of the railway bill, but that, before the latter gentleman had definitely settled the principle of construction, he had availed himself, in the most extensive way, of Mr. Fairbairn's advice, assistance, and sound practical experience. In a late impression of the *North Wales Chronicle*, we find a letter, written we know not by whom—unless we are to consider the existence of Mr. "Jobson Gurton" as an actual fact—in which the point is so pithily put, that we shall here quote it:—

"Mr. Fairbairn accords to Mr. Stephenson the original idea of riveted plate, supported by chains; but he claims the merit of having determined the best, that is, the strongest form in which the tube should be built. Mr. Stephenson's evidence does not in the least militate against the claim. Mr. Stephenson projected an *elliptical* tube. Mr. Fairbairn proved by experiment that a *rectangular* was not merely a better, but the best form of tube.

"This, I take it, settles one part of Sir Francis Head's business; for if one man suggests a particular form of thing, and another man finds that a different form is better, the latter's practice supersedes the former's theory, and entitles him to the honour due to a discoverer.

"The chain part of the affair appears not so clearly in Mr. Fairbairn's favour, but it is in appearance only.

"In October, 1846, Mr. Fairbairn asserts that Mr. Stephenson, after witnessing some experiments made to show the uselessness of the chains, resolved to abandon extraneous support for the tube. True, will reply Sir Francis; but in May, 1845, Mr. Stephenson was of opinion that a tube would be strong enough of itself. Admitted; but when asked in Committee whether he had made up his mind as to the safety of dispensing with chains, he answered, *No, I have not.* In what way, then, does this misty idea of Mr. Stephenson, entertained in May, 1845, vitiate Mr. Fairbairn's assertion, that it was in October, 1846, that he resolved to abandon the suspending chains; and that the abandonment was in consequence of Mr. Fairbairn's representations? In no conceivable way. Mr. Stephenson was of *opinion* that an *elliptical* tube would be the best; and, as we have seen, Mr. Fairbairn proved that the latter opinion was worthless. I do not understand why we should, on the evidence, hesitate to accord him the merit of demolishing the suspending chains."

So much for the Conway dinner speech, in which both of these facts are distinctly denied.

The second charge we should have thought was clearly enough disproved by the simple production of the minutes of the Chester and Holyhead Railway Company, which we have before quoted at page 113 of our second volume; wherein it is indisputably shown to us—though not to Sir F. B. Head—that the directors themselves conferred upon Mr. Fairbairn the office of *joint* engineer with Mr. Stephenson. We need not go further than this.

In the third section, we have the one only novelty—a grave one, we confess—which Sir F. B. Head brings forward. Mr. Fairbairn's position in relation to the Chester and Holyhead Railway Company, coupled with his known constructive skill and extensive practical resources, would obviously assign him a favourable standing in the estimation of the promoters of the undertaking, as a contractor for the execution of at least a portion of the work required. But the assertion that he, or any servant of the company, *could* allot to himself any portion of the contracts, carries with it the essentials of all that is ludicrous. The contracts for the several tubes were actually allotted according to the usual form of open tender; the firm of Messrs. W. Fairbairn and Sons being invited to estimate along with other engineering firms of eminence;—and in addition to this, the contract eventually taken, was settled and accepted through the London branch of the firm, without the knowledge or interference of Mr. Fairbairn himself. We have before us the correspondence in this negotiation, and therefore merely give a statement of actual facts. A thought on one of the moral precepts of our school-day copy-books, might have been serviceable to the propounder of these three charges. "Overmuch zeal may produce mischief." How well this truism applies here, where, on the one side, we are told that Mr. Fairbairn has credit only as a tolerably active assistant; whilst, on the other, a return thrust is given in the shape of a statement that he—the assistant, mark—"allotted to himself a most lucrative contract."

In dismissing the subject—which is painful to all who feel the indignity suffered by science in the quarrels of her followers—we must award to the author of "Truths and Tubes," no little praise for the manner in which he has executed his task,—with very poor materials, he has given us a very elegantly written book.

Counsel to Inventors of Improvements in the Useful Arts. By Thomas Turner, of the M[illegible]emple, London. Elsworth. 1850.

Mr. Turner, whose work on a kindred subject we lately reviewed, has again come before the public in this book of smaller size, but of greater import. To attempt to instruct the instructor, to benefit the benefactor of mankind, is no ignoble effort; while to give counsel to inventors would seem to imply the consciousness of a position commanding the right to

be heard. No arroganee, however, of this kind is to be found in this little unpretending and useful volume. It is divided, as the subject naturally divides itself, into two parts. The first part treats separately of inventors, inventions, and the remuneration of inventors. Part II. exhibits the writer's views of the rights of inventions, of patents, of subjects patentable, of registration, and, lastly, of the speeification and other proeeedings. These several portions of the subjeet-matter are diseussed in a popular and amusing manner—all is simple, all is intelligible. He brings to his task a fund of general and scientific information, which is a desideratum in works of this class, while here and there suggestions are thrown out of great practieal and even philosophical importance. We are glad to see him boldly reprove those who ascribe the term "projeetor" as a name of reproach to that class "to whom (though euriously slighted by almost all the political authors, from Adam Smith to John Mill) we owe no small portion of our national prosperity," (Preface.) "*Tais-toi, Jean Jacques, ils ne vous comprendront pas*,"—"Hold your tongue, Jean Jacques, they wont understand you,"—might have been the precept to be followed in some cases, when it was expressed by the acute and knowing philosopher of Geneva; and, unfortunately, it may be so even at the present time. But Mr. Turner would reverse this precept, as far as projectors are concerned, and say—"Never mind; speak out, man, let us hear at least what you have to say respecting any kind of improvement—any kind of fancied or real information you may have to give us—speak out boldly." Before Newton *proved* its truth, Copernicus had adopted the thought of Pythagoras as to the present recognized solar system. It would be difficult to show projeetors of a higher *calibre* than these latter two; and who can say how much of Newton's fame may really be attributable to the idea inherited by him from these his fathers in astronomy! We are inclined to agree with the author, that in every case the "projector" is, to a certain extent, an absolute inventor. Such was Watt when his first brilliant thought oceurred to him, and long afterwards, and indeed until after daily labour and nightly toil,—now we may reasonably conceive obstructed—now removing obstruetions—now thinking his idea but erroneous fancy—now urged on by irresistible proofs of its truth and significancy,—he finally produced the machine which has given new life and energy to the whole world. What greater projector than Jacquard must have been to himself, when, by a few pieces of wood and iron and cord, he conceived his loom performing labours which could not otherwise be done! The time is past for regarding such ideas of such men as the results of idiosyncracy or monomania, of fraud or villany; and the time is fast coming when inventors shall, as they must, stand as a separate and influential class and profession. Invention is getting more and more diffieult to the only slightly edueated in the subject of the invention; and this class, this profession, must eventually hold a conspicuous place in the economy of nations. The inventor must, obviously, be the "all-knowing" of what has been already done in the matter. He as obviously stands above it, looks down upon it as it were, sees its errors, provides remedies for them, the very best remedies in the world,—progressive steps—links without which we could never ascend to the temple of improvement, and never catch a glimpse of that chain of providence which constantly encircles multiplying humanity, and by which successive peoples are better fed, better clothed, better housed, and all their powers better brought out.

The inventor must be in an eminent degree the best instructed in his department. How many unprofitable hours have been thrown away from the neglect to acknowledge this truth, or from not having been initiated into the knowledge of it! How often has the mechanic seen his best and truest metaphysical labours but the expression of truths long known; and the poet or divine confuted in his egotistic self-laudation, in the discovery of a well-known instrument, but unknown to him! An observant child may go out into the fields, and among the rocks of his neighbourhood, and make great diseoveries, which "the botanist" or "the geologist" may smile at, as but recalling the remembrances of the facts brought before his mind in his own youthful studies.—But we are encroaching on the province of the counsellor of inventors. We had marked two or three passages for extracts; the space, however, already devoted to this little work precludes us doing so. We shall be happy to meet Mr. Turner on another occasion in a still wider field, and in a more extended treatise, for this is one of the real "latter-day pamphlets."

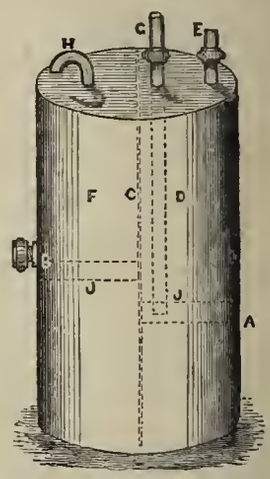
This book presents the same defect which we noticed in Mr. Turner's former production, namely, a want of division into sections. Logically, and in the table of contents, this volume is so divided, but not to the eye, which deteriorates in some degree, in any book, however small, from its utility for reference. It is almost hypereritical to notice a saying ascribed to Falstaff, in page 27, which Shakspeare puts into the mouth of "bluff prince Hal," and another to Talleyrand, "Speech is given us to conceal our thoughts," which has long since been shown to have originated with M. Harel, a French wit preceding him.

CORRESPONDENCE.

REGULATOR FOR CONTRACT GAS-LIGHTS.

This little apparatus is intended to afford Gas Companies the power of shutting off the supply of gas from the burners of consumers who use no meter for determining the quantity of gas which they use, or those who burn by contract, a certain number of hours per day, at a certain price. Altbough the meter system is now so general, there is yet a large class who keep up the old contract mode; and it is hardly necessary to say, that great liberties as to time of burning are frequently taken.

The contrivance is little more than a plain cylindrical vessel of tinned iron, or other suitable material, containing water, whieh, when the pressure is full on, stands up to the levels, A and B, which are determined by the usual water-levelling screw at B. A diaphragm, C, passing down the centre to within one-eighth of an inch of the bottom, divides the vessel into two equal sections, and the gas is conducted into the section, D, by the entrance-pipe, E. When the gas flows in by this pipe, the pressure acts on the surface of the water, depressing it in the section, D, and elevating it in the corresponding seetion, F, as shown, through the communicating opening at the bottom. The depression of the water on the gas-entrance side then opens the lower end of the exit pipe, G, leading to the burners. So long as the regular pressure is kept up at the works, the inner open end of the pipe, G, will be open for the free supply of the burner; but when the pressure is purposely redueed in the supply pipe, the water-level on the entranee side again rises, and shuts off the supply to the burner, by covering up the end of the pipe, the water-levels in the two sections being represented by the lines, J J. The little bent pipe, H, is the air-outlet from the seetion, F. The regulator will, of course, be most effective, where pressures exceeding one inch are used.



James Kirkpatrick,
March, 1850. Engineer, Dumfries Gas-Works.

[This is a simple mode of remedying the evils consequent upon a laxity of attention to their stated periods of burning, on the part of the "contract" consumers; but it appears to have the objection—whether great or little—attendant upon the working of two pressures. After having the full pressure on for the supply, those consumers who use meters, —and, consequently, have the liberty of burning to any hour they choose —must be ineonvenienced by the reduetion of pressure necessary for the regulation of the time of their contract neighbours. The differenee in pressure will, in these cases, require to be accounted for by the supply stop-cocks. In districts where a separate supply is afforded to contract burners, of course this objection will not apply.—Ed. P. M. Journal.]

ON STEAM-BOAT PROPULSION.

When a vessel is propelled, no matter by what kind of power, a wave (resisting wave) is produced, as water is displaced. To overcome this resistance by finding a support on the water itself, a corresponding wave (propelling wave), in an opposite direction, must be produced. As the resistance of water to bodies moving in it, increases with the squares of the velocity, a steam-vessel should be propelled by means which produce a propelling wave, by giving great velocity to a small quantity of water, and the resisting wave which has to be overcome, should be of moderate velocity and great quantity of water.

The following classification of the different kinds of propulsion in steam navigation, will show their comparative merits in this point of view.

A screw-propeller being deeply immersed, produces a propelling wave of very little velocity, but considerable quantity. A paddle-wheel with moveable boards—as Morgan's—produees a propelling wave of less quantity, and greater velocity. A common paddle-wheel with plain boards, produces most directly the propelling wave of greater velocity, and less quantity of water.

The greater the velocity with which the propelling wave is produced, the greater is, of course, the so-called *slip*, generally most erroneously considered as *loss of power*.

I may here add, that, with the screw-propeller, there is a constant expenditure of power by displacing water with a considerable velocity, only tending to turn the vessel on its beam ends. In Morgan's wheel we have friction added, whilst in the plain paddle-wheel there is no such useless expenditure of power.

Manchester. C. SCHIELE.

SCREW-PROPULSION.

As the subject of screw-steaming occupies a good deal of public attention, and its onward progress is watched with considerable interest in this quarter, it would, I am sure, prove interesting to many of your readers, were short notices given, through the medium of your journal, of any improvements which may be made on the Clyde in this mode of propulsion, or in the modelling of vessels to be propelled by the screw.

A SUBSCRIBER.

Liverpool, March 13, 1850.

[We have in contemplation some practical papers on Screw-Propelling; and such of our readers as are in a position to afford any information on the subject, may materially assist us by contributing notes, no matter how brief.—ED. P. M. JOURNAL.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

FEBRUARY 19, 1850.

WILLIAM CUBITT, ESQ., PRESIDENT, IN THE CHAIR.

The paper read was a "Description of the Iron Roof over the Railway Station, Lime Street, Liverpool," by Mr. Richard Turner. The area covered was described as being 374 feet in length, and 153 feet 6 inches in breadth, which was roofed over in one span. The roof consisted of a series of segmental girders, or principals, fixed at intervals of 21 feet 6 inches from centre to centre; these were supported, on one side, upon the walls of the offices, as far as they extended, and on the other upon cast-iron columns. From the end of the offices to the viaduct over Hotham Street, a distance of 60 feet 4 inches, the principals were carried upon a "box beam" of wrought-iron. The principals were trussed vertically, by a series of radiating struts, which were made to act upon them, by straining the tie-rods and diagonal braces; they were trussed laterally, by purlins and by diagonal bracing, extending from the bottom of the radiating struts, to the top of the corresponding strut, in the adjoining girder: these braces were connected with linking-plates by a bar of the same scantling, and also with the purlins already referred to. The girders were thus firmly knitted together, and a rigid framework formed, upon which the covering of galvanized corrugated iron and glass was laid.

The whole construction was minutely described, and the appendix contained an account of the experiments for testing the strength of the principals. These were made at the works of Messrs. Turner & Son, Dublin, under the direction of Mr. Locke, the engineer of the railway, when some great improvements in the construction were introduced at his suggestion.

FEBRUARY 26.

"On the Street Paving of the Metropolis, with an Account of a peculiar system adopted at the London and North-Western Railway Station, Euston Square," by Mr. William Taylor of Birmingham.

The paper commenced by directing attention to the importance of a good system of paving, in conjunction with a more perfect plan of sewage for all large towns. The paving of the metropolis had too long been carried on under an antiquated and unscientific system, of using large masses of granite, placed upon an insufficient substratum; the consequences of this were great noise, an imperfect foot-hold for the horses, danger of the constant fracture of the springs and axles from the jolting over an uneven surface, and great expense of repairs. The "macadamized" streets were manifest improvements on such a system, but the surface was not found capable of resisting the heavy traffic of the main thoroughfares of the city. The defects of the wood pavement so greatly exceeded the merits that it had been nearly abandoned.

Impressed with the disadvantages of the present system of paving, Mr. Taylor tried an experiment about ten years ago, by covering a surface subject to very heavy traffic, and subsequently, about five years since, entirely paving the departure side of the Euston Station of the London and North-Western Railway in a peculiar manner. The system was upon entirely new principles. The method employed was, after removing the subsoil to the depth of sixteen inches, to lay a thickness of four inches of strong gravel, equally and well rammed, then another layer of gravel mixed with a small quantity of chalk, or hoggin, for the purpose of giving elasticity, the ramming being continued as before; a third coat, of the same materials, was then laid and rammed, a regular degree of convexity of surface being preserved. The stones used were of Mount Sorrel granite, dressed and squared into regular masses of four inches deep, three inches thick, and four inches long: these stones were laid in a bed of fine sand, one inch in thickness, equally spread over the surface of the substratum, and they were carefully placed, so that no stone should rock in its bed. The whole surface was then well driven down with wooden rammers, weighing fifty-five pounds each. The small size of the stones enabled them to be well rammed home, so that the surface of the pavement never sunk, and the hardness and toughness of the material, prevented the stones from being worn down by any traffic, however heavy.

It was stated, that this system was found infinitely preferable to the employment of large stones, and the statement of cost was vastly in its favour; the price of the ordinary kind of granite paving, in London, being eighteen shillings per superficial yard, and the maximum cost of the new or "Euston" pavement, including the substratum, was not twelve shillings per yard, and deducting the value of the old stones (not in this latter case), claimed by the contractor, the net cost would only be nine shillings per yard.

The system was stated to have been very extensively employed at Birmingham and many provincial towns, and it appeared admitted, that the beauty of the pavement when completed, was only equalled by its extreme durability, and by the manifest advantages it offered in its noiselessness, good foot-hold for horses, freedom from jolting, and the small repairs it required.

It was suggested that the different Paving Boards should make a trial in streets of small traffic, by lifting the large stones, and cutting them into small cubes, or rectangular pieces, of three inches in depth, for the future pavement; so that a good field would be afforded for the practice of the pavers, which would enable them to be better qualified for the task of extending the system to the more important thoroughfares: by this means, too, a large surplus of stone would be accumulated for paving, and the refuse would be valuable for macadamizing the roads in the outskirts.

MARCH 5.

Before the business commenced, it was announced by the Secretary, that an electric telegraphic despatch had been received, communicating the gratifying intelligence, that at seven o'clock in the morning of Tuesday, three locomotive engines and twenty-two loaded coal waggons, weighing in all three hundred tons, had passed through the Britannia tube, over the Menai Straits, with perfect safety, and very satisfactorily to Mr. R. Stephenson, the engineer.

The discussion was resumed on Mr. Taylor's system of Street Paving, and was extended to such a length as to preclude the reading of any paper.

It was contended that a rigid and unyielding substratum had been tried by Mr. Telford many years since, and had been used with success in some parts of the city paving, up to the present time. The average duration of the pavement of the streets in the city was stated to be eight years, but that it was constantly subject to injury, from being moved by the water and gas companies. The pavement on London Bridge by Sir John Rennie was instanced as a good but expensive example of the use of long narrow stones; and that by Mr. Walker, on Blackfriars Bridge, was quoted as another instance of the success that might be attained by great care in the preparation of the substratum, which was of concrete, and the stones of the pavement being laid with more than ordinary skill and care. The results in both cases were eminently successful, but it was allowed that such an expensive system, however beautiful, was not applicable to the ordinary streets.

It was admitted, that, although the principal streets of the city, and the main thoroughfares of the west and east ends were well attended to, yet it must be allowed that the paving of the majority of the streets was not in a satisfactory state, and it was attributed, in a great degree, to the want of a definite system being adopted; there being too many authorities in the shape of parish paving boards, each of which had a separate surveyor, too often equally inefficient and ill paid. The water and gas companies appeared to vie with each other in their endeavours to destroy the paving; and a portion of the Strand was quoted as having been removed thirty times within two years.

With respect to Mr. Taylor's system of paving, it was contended, that the Mount Sorrel granite was a very superior material, both as regarded its toughness and durability, and that its natural structure enabled it to be worked very advantageously into the small cubes. The main feature of the system was the selection of the material for the substratum, and the careful preparation, so as to afford a sufficiently rigid, but yet imperceptibly elastic bed, whereon the small cube stones should rest. These stones being well driven down by repeated blows of light rammers, attained a degree of solidity which defied the heaviest traffic; and in the towns where the system was employed, considerable economy had resulted. The surface of the paving approached as nearly as possible to that of a macadamized road, affording even a safer foothold for the horses, and with less noise of passing vehicles. The surface possessed extraordinary durability, and it might be considered as a solid mass of granite. It was announced, that within a few weeks there would be specimens of Mr. Taylor's system of paving laid down at the entrances of Hyde Park, where they would be subjected to regular traffic of a destructive nature, and which would be under constant observation.

A model of an improved Crossing Point was exhibited by Mr. Duncan of Leeds; the notch in the rail was shown to be done away with, and the two rails in it were so dove-tailed together, as to render any vertical motion between them impossible, thus materially strengthening the crossing.

A piece of brickwork, set in Greave's blue lias lime, and which had been kept under water for nine days, was also exhibited. This material was composed of one-third of lime to two-thirds of burnt clay; and it was stated to have been used with great success in the tunnels on the Great Northern Railway, as well as in many hydraulic works, in which it was as durable as cement.

INSTITUTION OF CIVIL ENGINEERS OF IRELAND.

The fifth ordinary general meeting of the Institution of Civil Engineers of Ireland, for the present season, was held on the 12th inst., at the Custom House—Lieut.-Col. H. D. Jones, R.E., President, in the Chair.

The following important communication from the Council was then read:—

Extract from the minutes of Council, 8th February, 1850.

Resolved—"That three prizes, in the order of merit, one of the value of £10, and two of the value of £5 each, in books, be awarded for the three best papers on civil or mechanical engineering, or the application of science thereto, which shall be presented to and read at the meetings of the Institution of Civil Engineers of Ireland, before the 31st May, 1851.

"The Institution does not pledge itself to publish in its Transactions any papers so presented, or to award any prize, unless original papers of adequate merit be presented.

"Competition is free to all persons engaged in the pursuits of civil or mechanical engineering, or the practical application of science thereto, except the Council or officers of the Institution.

"Authors are not at liberty to choose their own subjects, but contributions on the following or analogous heads are suggested by the Institution as important."

(The subjects will shortly be announced.)

In resuming the discussion on Mr. Hemans' paper (read at the last meeting) "on the construction of the Midland Great Western Railway through the bogs of Meath and Westmeath," Mr. W. T. Mulvany, V.P., offered some remarks relative to the advantage of extending the drainage operations, so as to embrace a considerable extent of the bog on either side of the railroad; also recommending the loading of the sides with the excavation, so as to counterbalance in some degree the portion occupied by the road.

Mr. C. Bournes described the plan adopted in the formation of the Great Southern and Western Railway, over a bog in the Queen's County, under his charge. In this case a different plan from that stated in Mr. Hemans' paper was pursued, as the bog was excavated, and soling used, and the result was quite successful.

Mr. MacMahon exhibited and explained "a model of an Improved Railway Waggon." This waggon was invented by Mr. Larkin, and was used very successfully in the construction of an embankment at Youghal. The peculiarity of the invention consisted in the waggon being constructed so as to carry its own turntable, which was of vast utility in the formation of narrow embankments.

The President read a report by Sir Robert Kane, on the analysis of specimens of water from the Shannon and Lough Ree, also of lime and mortar, with a view to ascertain, if possible, the cause of injury sustained by certain works, from the efflorescence of the mortar, when in contact with the river Shannon, from between the joints of the masonry.

INSTITUTION OF MECHANICAL ENGINEERS.

January 23.

ON THE DETERIORATION OF RAILWAY AXLES.

The adjourned discussion on railway axles was introduced by reading the following additional paper by Mr. M'Connell:—

Having been requested at the last meeting to furnish further proofs of the change from the fibrous to the crystalline character produced in railway axles, and feeling convinced that a strict and careful examination of this important subject is a *necessity* in this age of railway practice, the inquiry has been resumed in the hope that the further information and experience gained may tend to a more perfect knowledge of the subject

Before stating the results of the different experiments which have been made with the view of ascertaining the cause and extent of the change from the fibrous to the crystalline appearance in railway axle iron, it must be observed that in this, as in some other matters of controversy, it is most difficult to produce full and conclusive proof that the iron which is produced of a crystalline character was once fibrous, as we cannot by any experiment show the change visibly taking place; but surely it is fair and reasonable to admit the *fact* of a change, when we find railway axles when new, from the particular mode of manufacture, present, through every part of their substance, a tough, strong, fibrous appearance, yet, after several years' use, we find axles of the same description, owing to the various deteriorating causes in action, break short at the back of the wheel, and then present an appearance totally different from the original structure of the iron, as described above.

It has so happened, in strong confirmation of the views stated by the writer at the former meeting, that a very remarkable instance of this change was brought under his notice shortly after that discussion; and he thought the evidence which this case furnishes so important and conclusive, (although produced without any design, and in the ordinary course of business,) that the axle has been brought for inspection of the present meeting.

This axle was fixed in cast-iron wheels, of the pattern in use on several lines of railway, having the H form of spoke, and, as this wheel is perfectly rigid, experience has proved that the axles are much more liable to deterioration when working in these kind of wheels than in those wheels made partly of wood or other construction of wrought-iron, &c., which may have a certain amount of elasticity.

The axle now under consideration broke, in ordinary working, close at the back of the wheel as is usually found, and the fractured ends, which are now produced to the meeting, afford the most distinct proof of the annular space, which was stated on the former occasion to be observable all round the surface of the fracture; and this is not only short-grained and crystalline, but there is also, in the writer's opinion, an evident distinct separation to the extent of the annular space, which, it would appear, takes place some time before the final fracture, as if each successive blow, heavy or light, lateral or vertical, received or transmitted through the wheels, had each tended to destroy its proportion of cohesion of the previously crystallized substance of the axle at that particular place where the fracture occurs.

On receiving this axle in the workshops, with one wheel still attached, it was allowed by accident to fall a short distance from the waggon to the ground, and so brittle had it become next the wheel that the other end snapped off simply from the effect of the fall, and shows, as will be observed, a precisely similar appearance to the original fracture.

The writer was anxious to ascertain how far the theory which he held was correct, that the deterioration of the axle was principally local at that point (the back of the wheel), and for this purpose he caused the centre of the axle between the two fractures to be laid on supports, with the view of breaking it. A weight of cast-iron weighing 17 cwt. was then allowed to fall upon it through a space of 14 feet; but, after several attempts, it was found to make no impression upon the centre part of the axle towards effecting a fracture, although it was a frosty day, which would of course render the iron more brittle. Finding all efforts to break it by blows fruitless, the axle was then, in order to test its fibrous character, taken to the hydraulic press, and it has been bent to the form of the letter U, until the two ends met, without showing more than the slightest appearance of the skin of its surface breaking, as will be seen, proving still to be of a strong fibrous iron in the centre of the axle.

Following up his proposition, the writer wishes to lay considerable stress on the view he previously stated, respecting the effect of the blows or vibrating action given through the wheels to the axle; he attributes the crystallization of the axle at that point close behind the wheel, to the sudden stoppage or reaction of the vibratory wave at that place, owing to the check which it meets from the mass of matter, consisting of the wheel, &c., presenting a break of surface, and acting more as an anvil, causing the vibration to react like a blow on the neck of the axle (the nearest weakest point), thereby destroying its fibrous character.

Cast-iron wheels, therefore, are objectionable from their rigidity and non-absorption of the lateral and vertical concussion with other strains formerly enumerated, received in course of working, and transmitted to be wholly expended on the axle; and the writer endeavoured to illustrate this by a comparative experiment with two different axles of the same description and age, one being fixed in cast-iron, and the other in wooden wheels, those known as the Pimlico make.

1st Experiment was made on the axle with wooden wheels placed horizontally resting upon the rails; a weight of 17 cwt. was allowed to fall through a distance of 13 feet 3 inches upon the axle, immediately within the wheel, by which the axle was slightly bent at the point where the blow came, and a portion of the tyre resting on the rail was broken clear out. This experiment was repeated four times on the other end of the axle, which was bent but very slightly, and the wheel was rendered completely useless.

2nd Experiment was made upon the axle with cast-iron wheels placed as in the former case, and the same weight was allowed to fall the same distance at the back of the wheel, when the effect of the first blow was to break the axle at the other end, at the back of the wheel; thus proving that in the former case the axle was saved from fracture by the wooden wheel absorbing its full share of the effect of the blow, and the tyre of the wheel breaking proved that in course of working it would receive a portion of the deteriorating forces tending to crystallize, the wheel acting like a cushion to soften the blows before they reached the axle; in the latter case the rail supporting the cast-iron wheel was fractured in three places.

A 3rd Experiment was tried with another axle with cast-iron wheels placed as before, and received four blows on each end of the axle within the wheels, which caused it to bend, but produced no fracture. This axle had not been much used, and was of a stronger fibrous character.

In order to ascertain the relative appearances of axles which had been in use, and determine the position of the crystalline change, both at the centre and outer surface of the axle, the writer caused four axles which had been condemned as too small from wear in the bearings, to have a groove cut in two cases on each side, to within an inch of the centre, and in the other two, grooved through to within an inch of the outer surface; these were split asunder with wedges, and their appearances will show that a certain change has been going on, and this is more observable in one end of the axle than the other, attributable, he believes, to the break being applied to the wheel which was on the end where the greatest crystalline change is visible.

He has made a number of other experiments in the presence of several of the members of the Institution, with the view of determining the effect produced on the fibre of iron by the cold-hammering process. The following are the principal results:—

No. 1. A piece of ordinary bar-iron $2\frac{1}{2}$ inches wide and $1\frac{1}{8}$ inch thick, received 20 blows to nick it across, and was broken with 21 blows of a 14 lb. hammer, showing a fracture part fibrous and part crystalline.

No. 2. The same bar received 52 blows on one side, and 55 on the other, from the 14 lb. hammer, with 20 to nick it as before, and it broke with 14 blows, showing different layers of fibre and crystal.

No. 3. The same bar received 50 similar blows on each side as No. 2, but each blow on alternate sides successively, and 20 in nicking, and 9 blows broke it.

No. 4. The same bar was not cold-hammered, but received 20 blows in nicking, and required 28 blows to break it, showing a good fracture.

No. 5. Was a $\frac{7}{8}$ inch square bar, received 50 blows on each of two opposite sides, and 25 on each of the other sides, with 4 blows in nicking, and 5 broke it.

No. 6. Without any cold hammering and the same bar, after receiving 4 blows to nick, required 6 to break it.

No. 7. The same as in the case of No. 6, had no cold-hammering, with 4 blows to nick it, and required 30 blows to break; in this case it was broken the flat way of the pile of the iron, but in No. 6 it was broken the edge way of the pile.

No. 8 Experiment was made on a shaft $3\frac{5}{8}$ inches diameter, which was cold-hammered at one end, having received 204 blows on all sides from a $3\frac{1}{4}$ ton tilt hammer; 110 blows with a sledge hammer were given to nick this end all round which had been cold-hammered, and it required only 5 blows from the $3\frac{1}{4}$ ton hammer to break it; the other end, which had not been cold-hammered, after receiving the same number of blows in nicking, required 78 blows under the $3\frac{1}{4}$ ton hammer to break it, thus proving the enormous amount of deterioration of the strength of the iron caused by the cold-hammering process.

No. 9. A piece of round iron $2\frac{3}{8}$ inches diameter, which had two bearings turned (one at each end) $1\frac{7}{8}$ inch diameter by $2\frac{1}{2}$ inches long, was allowed to run at a considerable velocity for about an hour, with one end oiled and the other dry, the dry end being cooled with water repeatedly when it became hot; the iron was then experimented upon in order to determine, by the different force required to break the end which had been injured by want of lubrication, the relative strength of each bearing; but such was the remarkably tough quality of this iron, that although it received 520 blows of a heavy sledge hammer in every possible way to break it in one direction (without being nicked), no fracture could be effected, but the iron seemed to be drawing out at the back of the journal on end, as will be seen by the meeting.

This last case is noticed in particular, as the following experiment of a similar character with an old axle of larger dimensions, shows in strong contrast the altered nature of similar iron from use on a railway, owing to the jar or vibrating action it has suffered.

In the 9th Experiment a piece of new iron intended for part of an axle, although run dry and cooled with water, yet was so fibrous, having received no jar, that it resisted all effort to break it.

No. 10. Another Experiment of a similar character was tried on an old axle which had been a long time in use, of the same kind of iron and manufacture as the bar in No. 9 Experiment. This axle with the wheels on was run in its own bearings in a lathe at a velocity equal to ten miles per hour for 5 hours; one journal was kept running dry, and when heated by the friction cooled with water, while the other journal was kept well lubricated with oil. When taken out, the journal which had been heated was broken with 12 blows of a hammer 22 lbs. in weight, while the lubricated journal required 91 blows with the same hammer to break it, in both cases without being nicked; this appears satisfactorily to prove the injury to the axle which results from the practice of throwing cold water on the journal to cool it when it has become nearly red hot from the want of proper lubrication.

ROYAL SCOTTISH SOCIETY OF ARTS.

February 4, 1850.

In our last reports of the proceedings of this Society, we gave the earlier portion of Mr. Buchanan's paper on the strength of materials, and on the tubular bridges. In the second portion of this valuable communication, the author elicited a number of very important facts relative to the strength of various stones; concluding with an interesting detail of the lifting apparatus, with general constructive particulars of the Britannia tubes. The great space which a report so elaborate would occupy in our pages, prevents us from giving it entire; we must, therefore, refer our readers to the Society's report for further information upon it.

"On a Machine for Mortising, Tenoning, Boring, and Ripping Timber," by Mr. William R. Douglas, Mechanic, Inveralmond, Mid-Calder.

It was stated that this machine, in all its parts, possesses great advantage over hand labour; and, as all the parts are useful for the trade, it is a saving of room and framing to have them connected.

The mortising is done by a fly-wheel and double-crank, connected to a crosshead similar to an engine, in the centre of which is fixed the mortising iron, the wood passing under it between two guides, the one fixed and the other elastic, to suit wood of unequal thickness.

To tenon, the mortising iron is taken out, and the frame containing the two saws is fixed to the crosshead. On the driving shaft is fixed an eccentric shove, which communicates the motion to a ratchet fixed on the end of a roller to which is fixed one end of a rope; the other is attached to a slide-carriage, on which the wood is conveyed to the saws or mortising iron.

To bore, a journal is put into the centre of the crosshead containing the auger, which is coupled to a square iron rod, which is made to move easily through a shove and fly-wheel placed on the top of the framing, the motion to which is communicated from a shove placed outside the framing; any amount of pressure may be obtained by adding weight to one side of the large fly-wheel. The motion is communicated to the ripping saw by the large fly-wheel. The crosshead requires to be disconnected during the time of ripping.

"On a method of introducing an abundant supply of fresh Air into Coal-Mines, and of preventing the accumulation of Fire-Damp therein," by Mr. William Shedden, at Mr. Hawthorn's Engine Works, Leith.

The author gives the following abstract of his method:—Fans have been long used for winnowing corn. They are used for smelting cast-iron in foundries. They are used for blowing smiths' forges. They are used by brewers and distillers for cooling their liquors. They are used for ventilating large buildings. The question occurs—could they not be efficiently used for ventilating coal mines? Fans being of such general use, their properties are well understood. By their rapid rotatory motion they send off a large current of air from the extremity of the blades, and by which means a partial vacuum is created at the centre. Attach a pipe to this centre, and let it go along the roof of all the workings in the mine; thus the enemy will be withdrawn, and a constant circulation kept up. Let another set of fans be put in motion, and pipes attached to the extremity of the fan-box, and these pipes running along the bottom of all the workings, an abundant supply of fresh and wholesome air would be thrown in, restoring the equilibrium, and making it impossible for an explosion to take place. Any one of these fans would do alone, but the two combined would be far more complete. A small engine would answer the purpose, and for the price of fuel, it might be said to be nothing at a coal mine. I do not think it would be necessary to keep the engine in motion 24 hours in the day, perhaps 12 would be sufficient—a few hours before the miners commence work, and stop when they stop. The pipes alluded to do not require to be strong, nor their joinings to be air tight. By not being tight they will operate along their whole length.

It is calculated that since the year 1800, more than 20,000 human beings have been killed by explosions in coal mines in this country. In 1847 and 1848 more than 1200 lives were thus lost; and in 1849 upwards of 700.

ROYAL INSTITUTION.

February 8.

Professor Cowper "On the Conway and Menai Tubular Bridges." The Professor commenced by briefly distinguishing between the real tubular structure of Stephenson and certain foreign bridges, from which, as has been alleged, that principle was taken. Thus, the wooden bridge at Schaffhausen, which was destroyed by the French in 1790, and which was supposed to have suggested the tubular form, is proved by a model now in the museum of King's College, to have been simply an arched bridge, having a roof as a shelter from rain. The same remark is equally applicable to a bridge at Wittengen, and to wooden bridges in America, where the roadways are roofed. The Professor then read a brief notice of various proposals and estimates, by which it appeared that the attention of the legislature had been directed to the urgent necessity of a safe transit over the Straits of Menai since the year 1783. The most elaborate report was furnished by the late Mr. Rennie, who supplied several designs and estimates for bridges, either of cast-iron, or partly of cast-iron and partly of stone. Professor Cowper then proceeded to explain and to illustrate by models the principle of a bridge. He showed that the force exerted on the arch bridge is that of *compression* only; in the suspension bridge the force exerted is that of *extension* only; and that in the bow-and-string bridge both extension and compression are exerted. It was shown that the same forces are also exerted on the girder,—viz., extension on the under and compression on the upper side. This was demonstrated by the following experiment:—Wood, tin-plate, and tin tubes were successively inserted in a space of about four inches, purposely cut for that purpose, in the middle of a girder, where it was also jointed. When the tin-plate was inserted in the upper side, it bent under the pressure of a few pounds; but when rolled up into a tube it supported more than 100 lbs. Again, when the same piece of tin-plate was fixed to the under side of the girder, where the force of extension was called into action, it would have required several hundred-weights to have torn it asunder. Mr. E. Hodgkinson's experiments on the best form of section for cast-iron girders were then adverted to. Small experimental girders, devised by that gentleman, were shown. They resemble the letter T. It was stated that the strength of this girder, when the flat side was uppermost, was to its strength when inverted (⊥) as 1 to $3\frac{1}{4}$. Other forms of section showed that the distribution of the same quantity of material would give differences in strength, varying as $5\frac{1}{2}$, 11, 15, 19. It was then explained how wrought-iron tubes had been employed by Locke, Brunel, Fox, and Henderson, in the bow of bow-and-string bridges, and by Fairbairn in girders. The insufficiency of ordinary suspension bridges to support railway trains was adverted to; and Mr. Cowper explained a perfectly novel and highly scientific design of a railway suspension bridge, the invention of his son, Mr. E. A. Cowper. This bridge, from the principle of its construction, is called "The inverted arch bridge." An arch of an ordinary cast-iron bridge (like the Southwark Bridge) is secure in whatever position the load is placed, because the lines of thrust are contained within the arch of plates. Now, imagine a similar arch of wrought-iron plates to be inverted, and a roadway hung in it, then, wherever the load may be placed, the lines of strain will also be contained within the inverted arch of plates, and consequently there will be no deflection of the road. This very original invention is worthy the attention of engineers. Professor Cowper then explained Mr. Stephenson's original proposal to build, without interrupting the navigation by scaffolding, a bridge of two cast-iron arches, the centre pier being placed on the Britannia rock. It was shown by a model how two half arches could be built on the opposite sides of a pier, each being tied to, and so balancing, the corresponding voussoir on the other side. Other conditions imposed by the Admiralty, but incompatible with the plan of the railway, induced Mr. Stephenson to adopt the plan of a vast tube. A section, made of rope, comprising the full size of the tube, was suspended from the ceiling of the theatre of the Institution: it was 15 feet wide, and 30 feet high; and Professor Cowper stated the length to be 460 feet (about twice the height of the Monument). After many experiments on cylindrical, elliptical, and other forms, Mr. Fairbairn adopted that of a rectangular tube, with rectangular cells at the top. Professor Cowper illustrated, by experiment, the necessity of stiffness at the top of the tube, and demonstrated that this was obtained by the cellular form. The Menai tube is made with wrought-iron plates, varying from $\frac{5}{8}$ to $\frac{3}{4}$ of an inch in thickness, firmly riveted together, with T or ⊥ iron at the joints. The rectangular cells at the upper side are eight in number, and are I foot 9 inches square; and there are six similar rectangular cells at the bottom of the tube. The method of putting the tube together, and of raising it by hydraulic presses, was explained and exhibited by a model. The bridge consists of two lines of tube, extending over two centre spans of 460 feet each, and two smaller spans of 230 feet each. These tubes,

when in their places, were joined together by intermediate tubes of about 50 feet over the piers; thus not only making the length of one entire tube to amount to 1,524 feet, but by the junction adding considerably to the strength. The weight of the tubes is abnut 10,570 tons. The Conway tubular bridge has been in use for some time, and it is found that an ordinary train deflects the tube about $\frac{1}{8}$ of an inch; that hot sunshine causes the heated side to bow out about 1 inch; that the strongest wind deflects the tube about 1 inch. It is intended to put sliding stays between the up-train and the down-train tubes of the Britannia bridge, so that they will support each other against the wind. The difference of temperature between summer and winter will expand the entirc Britannia bridge about 12 inches: this is provided for by fixing the middle of the tube on the Britannia pier, and allowing the ends to rest on forty-eight rollers, about 6 inches diameter in the abutments; the rails in those parts being allowed to slide by each other.—On the table were the works of Fairbairn and Dempsey; some plates of the tubular bridge by Mr. E. Clark, the resident engineer; and two models of the Conway and Britannia bridges.

MONTHLY NOTES.

Meik and Watson's Signal-House, or Tidal Guage.—A neat and ingenious design of a tower for signal purposes, has been recently registered under the nnn-ornamental act, in the joint names of Thomas Meik, C.E. of Sunderland, and Henry Watson of Newcastle-on-Tyne. The erection is arranged as a tidal guage for harbour purposes, for the use of ships entering or leaving the harbour. The lower part of the building answers as a dwelling-house or office, having, on the ground floor, a neat entrance on one side, with three prnjecting windows on the remaining ones. The upper floor is lighted by four windows in the projecting gables; and from the centre, a square tower springs up from this floor to carry the tidal index, with the barometer dial below, the whole being surmounted with a pointed roof and pinnacle. A web of wire gauze, of a length suitable to the range of tide, and wide enough for the intended size of index characters, is moved upon upper and lower copper rollers, filling up a window in the top of the lower aperture, so as clearly to exhibit whatever characters are opposite to it. A well, communicating with the harbour, is sunk in the foundation of the building, and the float in it is connected to a copper wire cord, working upon a spirally grooved cone, on a shaft which carries, at its oppnsite end, a spur-wheel gearing with a pinion on a second shaft. A counter-weight is hung to a copper wire cord, passing over a guide pulley, and communicating with a cone and wheel arrangement, similar to that below. The web of gauze moves upward during the risc of the tide, when the float is being carried up, and of course the reverse movement takes place during the ebb. In both cases, the height of tide at any given time is indicated on the web opposite the sheet of glass which protects it. The web is made with a speed of 8 to 1 of the float, by means of the intermediate wheel and pinion; and the figures which are made to indicate the feet and half-feet of the tidal height, are, in the daytime, shown white upon a black ground. At night, when lighted from the interior in the usual way, the index figures appear brilliantly illuminated upon an opaque ground, a white transparent varnish being used for the figures. The whole design has a very handsome appearance; and it may bc satisfactory for our practical friends to know, that a guage of the kind is now in actual use at Sunderland harbour.

Hopwood's Portable Mangle.—This is a neat invention, recently registered by Mr. Hopwood of Scarborough. It is somewhat like the "vertical mangle" of Messrs. Tindal, of the same place, lately noticed in our pages. Two cast-iron standards, 15½ inches high, by 13 inches wide, carry the three rollers, the upper one of which is pressed down by a pair of levers, having helical springs on their ends to give the required pressure. These springs are contained in cylindrical boxes, cast on the front sides of the standards, so that nothing is seen but the spring spindle passing out at the top. A sloping cloth-board is attached in front, and from this the clothes are drawn in by a sheet attached to the centre roller, as in the earlier contrivance to which we have referred. To give power and ease of mnvement, a fly-wheel, 22 inches diameter, is carried by tho winch shaft.

Tebay's Universal Planning Rule.—We have beforc us a specimen of an ingeniously-arranged scale of equal parts, or, as the inventor—our old correspondent, Mr. John Tebay, C.E. of London—terms it, a "universal planning rule," which, he tells us, he has had in private use for several years, and has experienced great economy of time by the facilities afforded by it, as well for making original drawiogs as enlarged or reduced copies. It is of boxwood, but may be made of ivory, and is 12 inches long, with both surfaces slightly convex, thinning off to the edges, to get a close approximation of the index lines to the paper. As regards the saving of time effected by it, its merits on this head will be understood when we state, that it affords the means of dispensing with the use of compasses for all general purposes, being so contrived that all the graduations of the various scales may be brought to bear upon the paper, where they can be set off from the edges by a finely-pointed pencil. Thus the ugly pricking of compass points is avoided, and both the drawings and scales are less injured. It comprises two classes of scales, viz., feet and inches, for architectural and mechanical drawing; and chains and links, for plotting surveys. They may be readily distinguished, by the fractional sections of the former being divided into twelfths, and that of the latter intn tenths. Each scale of divisions reads to the edge of the rule, and the numbers read from right to left, all commencing from the same transverse line. The fractional sections read from left to right, commencing from the same line as the numbered divisions, and they also read to the edge of the rule; the subdivisions being indicated by corresponding notches upon the edge. All the scales are arranged according to equal subdivision; thus, 8 on the $\frac{1}{8}$th scale is equal to 4 on the $\frac{1}{4}$th, 2 on the $\frac{1}{2}$, and 1 on the 1-inch scales. The 10ths and 12ths subdivisions are at opposite ends of the rule, so that all the scales of each class may be read off the edge, from the smallest scale to the largest, by merely reversing the rule sideways, which is easily done in the left hand, being that in which the rule is held when nsed. Upon the ordinary 12-inch "universal planning rule" are the following scales,—$\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1 inch, subdivided into 12ths, for architectural and mechanical drawing, and the same number into 10ths, for plotting surveys. By having each of these two classes of scales upon separate rules, the 12-inch rule is made to contain the following scales,—$\frac{1}{8}$, $\frac{3}{16}$, $\frac{7}{32}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$, 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, 2 and $2\frac{1}{2}$ inch; whilst, by their peculiar arrangement, instead of such number produeing confusion, each scale can bc singled out and read off the edge of the rule with the utmost celerity and precision. It is made by Messrs. Horne, Thornthwaite, & Wood, of Newgate Street, London.

The Disc Engine.—Mr. Rufford has been ordered by the Admiralty to dismount his disc engine, fitted in the iron-steamer "Minx." She is to have her old engines refitted, and is then to be employed in the conveyance of stores between Woolwich, Deptford, Sheerness, and Chatham. We are not directly told, but are left to infer, that the "revived disc engine" is about to expire again.

New Treatment of the Fleeces of Sheep.—The enrolment of the specification of a rccently sealed patent of Mr. Smith of Deanston, will put us in possession of what we anticipate will be a most valuable piece of information on the subject of the efficient preservation both of the sheep and the fleece. The process is believed to be a very cheap one, and by it the fleece on the living animal is rendered repellent of moisture, so that, whilst the natural exhalations of the body are unchecked, the animal's health is preserved, and the wool is improved both in quality and growth. This species of waterproofing has been tested on some of the most exposed Scottish sheep-walks, with successful results. It is supposed that, at one-third of the cost, its application will entirely supersede the ordinary tarring and buttering; and another presumed advantage is, that it will lead to the successful introduction here of the Spanish sheep and Alpaca, by doing away with the—to them—fatal consequences of continued wet weather.

Extension of Smith's Screw-Propeller Patent.—Mr. F. P. Smith, so hnnourably known for his exertions in the introduction of screw propnlsion, has been successful in obtaining a five years' extension of his patent. The case was argued a few days ago before a Judicial Committee at Whitehall—Lords Brougham, Campbell, and Langdale, with Dr. Lushington and Mr. Pemberton Leigh, being present. The application was made by Sir F. Thessiger, who brought evidence to show that £30,000 had been expended in building the *Archimedes*, and in incidental expenses. It was also shown that no fewer than thirty-two ships of war, and a hundred mercantile steamers, had adopted the system; but owing to the conflicting claims of five several patentees, no more than two or three had paid any patent right. These have now all united for the defence of a joint cause, and it is therefore to be expected that all who have infringed the patents will be compelled to pay. The Admiralty, being interested in the question to the amount of some £25,000, opposed the extension, through the Attorney-General and Mr. Crowder. The examination of Captains Chappell and Crispen, R.N., and Messrs. Brunel and Galloway, however, resulted in the grant of an additional term of five years.

Coffey's Improved Still and Condensing Apparatus.—An ingenious and most convenient portable Still has just been invented by Mr. J. A. Coffey of London, promising many advantages in conducting the processes of distilling, evaporating, and decocting. The heat is derived from a gas-burner, supplied by a flexible pipe, and placed under the bottom of the boiler or still, the vapour from which ascends through the neck of the still-head into a cup-shaped vessel, containing an expanded shallow pan, communicating heat to an evaporating pan placed abnve it. In this way, whatever may be in the evaporating pan is operated upon directly by the heat. The vapour that may be condensed falls down the sides of the cup-vessel, passing by a pipe to a peculiar distillating condenser placed alongside of the heating apparatus, whilst the hot vapour ascends, and passes through an upper side pipe to a hot chamber above the condenser. There it circulates round the oven contained in this chamber, acting upon any matters cnntained in it; or in an evaporating pan forming the top of the whole, eventually passing off to the condenser at the bottom, whence it flows out by a side pipe. By a suitable arrangement of valves, the pans in the two vessels may be used to heat a retort. The apparatus is essentially a portable one, and may be removed and got into action in a few minutes, requiring no coal or fuel of any kind. The size varies from 1 to 1000 gallons. The one gallon still has a decocting pan 9 inches over, an evaporating pan of the same size, a sand-bath, and drying closet 9 inches square, also steam and liquor guages, safety-valve and condenser. The inventor states that it can be taken to pieces, washed, and put together again in five minutes.

The Great Waterloo Medal.—Thirty-one years ago, our then Prince Regent conceived the notion—such as regal heads alone may cnntemplate—of engraving a medal which should at once commemorate the Waterloo victory, and stand alone as an example of the high art of the period. The royal academicians met, consulted, and resolved, that to Flaxman should be intrusted the preparation of the design. This was done, but, by a strange misprision, this great artist lost the honour of so magnificent a work—in this way. Pistrucci, the present chief medallist at the mint, was, at the period of which we write, a new comer, but from his known splendid talents, he had received the appointment of chief engraver at the mint. When applied to carry out Flaxman's design, he at once refused to execute anything not his own design. Flaxman's production was, strangely enough, cancelled, and within twenty-four hours, a new model in wax was made by Pistrucci, submitted to the Prince Regent, approved, and ordered for execution; various occurrences conspired to delay the progress of the work, and, amongst the rest, arose the objection to a foreigner's holding the appointment of principal en-

graver. After a long continuation of turmoils and difficulties, Pistrucci was displaced, but retained as chief medallist, when he gave up his official residence, and retired to a cottage at Windsor, where he has since constantly worked upon the pair of dies. The size of this magnificent work of art is 5½ inches in diameter, and the actual time expended upon it, at Pistrucci's rate of eighteen hours per day, is calculated to amount to twelve years. No perfect dies fitted to strike complete medallions in hard metal of such a size as this, were ever before produced. About sixty figures, on the scale of the St. George on our crown pieces, also executed by Pistrucci, are contained in them. The whole work has been executed by engraving alone, without the application of a single punch. The subject on each side is allegorically treated, with the exception of the central part of the obverse, which contains portrait busts of the four allied sovereigns. No inscription is yet engraved on them, but it is intended to add the simple one—"Waterloo, June 18, 1815." It was George the Fourth's intention to have struck a series of the medals in gold—one to be presented to each of the sovereigns who contributed to the downfall of Napoleon, and one each to Wellington and Blucher. Others in silver were to be given to various persons of rank and power; and these silver ones, as well as others in bronze, were to be purchasable by the public. Each of the matrices weighs twenty pounds, and from this, some idea may be gathered of the great difficulty of obtaining perfect blocks of steel for the purpose. If political events do not again put back the time of completion, we may soon expect these dies to be hardened, and the medals issued.

Improvement in Wire Cards.—According to a recent patent of M. Boncher, a metal merchant of Paris, it is proposed to prevent the injurious effects of the oxidation of iron-wire card teeth, by coating the wire with some protective film. Several processes are mentioned by the patentee. In one, one ounce of sulphate of copper, and half an ounce of sulphuric acid, are mingled with five gallons of water at 86° Fahr., the wire being immersed in the mixture, thereby obtaining a coat of red copper, the due cohesion of which to the iron surface is obtained by a subsequent drawing process. In another mode, a coating of copper is given by a galvanic process. The mixture used is composed of 2½ lbs. of yellow cyanure of potassium and iron, and 4½ lbs. of carbonate of potash, with 5 gallons of water at 48° to 56° Fahr.—the bath being in connection with the negative pole of a battery. A plate of red copper is also immersed in it, being in connection with the wire on one side, and with the positive pole of the battery on the other. Other metals, as tin, brass, lead, or zinc, may be applied as a coating in this way.

Robertson's Pentagraphic Delineator.—This instrument, which was fully described and figured at page 230 of our first volume, has since been reduced by the inventor to a more portable and elegant form. Its use is to facilitate general outline drawing, sketching objects from nature as well as art, and likewise for copying any painting or drawing. From its simplicity, and the ease with which it can be worked, the amateur, though quite unacquainted with drawing, is enabled to make an accurate perspective outline of any object, and is thus assisted in overcoming the most difficult part of sketching and painting. In using it, the principles of perspective are clearly elucidated. The learner, after sketching any object with the instrument, may lay it aside and try his hand without it, referring to the sketch taken by it for position and proportion of parts. Thus, sketching from nature may soon be learned without the aid of a teacher. It is enclosed in a light mahogany case, adapted to a table or stand on a light tripod, which may be used as a walking-stick when travelling, and from its lightness and convenience it is easily carried about. With it the tourist and amateur can with ease sketch the more interesting objects of nature, and, in a great measure, derive the pleasure and satisfaction of the experienced sketcher, in having their attention drawn more closely to their beauties, and in having their forms pencilled down as a memorial of them. The apparatus fit for making a drawing 11 inches × 9 inches, weighs 3 lbs. We have seen an outline sketch of the cathedral, taken by this instrument; and, although done by a hand quite unaccustomed to drawing, this example clearly shows the value of the idea for grounding a beginner in perspective and proportion. The pentagraph itself is also now made by the inventor to suit the general mapping purposes of the surveyor's office.

ENGLISH PATENTS.

Sealed from 20th February, to 12th March, 1850.

Thomas Whiffen, Pigs Quay, Bridewell-Precinct, accountant,—"Improvements in machinery for registering the delivery of goods."—February 21st.

John Stephen Woolrich, Wednesbury, Stafford, chemist, John James Russell, Handsworth, in the same county, and Thomas Henry Russell, Wednesbury, aforesaid, patent tube manufacturers,—"Improvements in obtaining cadmium and other metals and products from ores or matters containing them."—21st.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in separating and assorting solid materials or substances of different specific gravities."—(Communication.)—21st.

John Slack, Manchester, Lancashire, manager,—"Certain improvements in the manufacture of textile goods or fabrics, and in certain machinery or apparatus connected therewith."—21st.

Alexander Hedlard, Paris, France, gentleman,—"Certain improvements in propelling."—21st.

George Holworthy Palmer, Westbourne Villas, Harrow-road, Middlesex, civil engineer and Joshua Horton, Ætna steam-engine boiler and gasometer manufactory, Smethwick, near Birmingham, Stafford,—"Improvements in the arrangement and construction of gas-holders."—21st.

William Cormack, King-street, Dunston-road, Haggerstone, Middlesex, chemist,—"Improvements in purifying gas, also applicable in obtaining or separating certain products or materials from gas, water, and other similar fluids."—21st.

William Mayo, of the firm of Mayo and Warmington, Silver-street, Wood-street, Cheapside, manufacturer,—"Improvements in connecting tubes and pipes and other surfaces of glass and earthenware, and in connecting other matters with glass and earthenware."—21st.

John Scoffern, Essex-street, Middlesex, M.B.,—"Improvements in the manufacture and refining of sugar, and in the treatment and use of matters obtained in such manufacture, and in the construction of valves used in such and other manufactures."—21st.

Charles Andrew, Compstall-bridge, Chester, manufacturer, and Richard Markland, of the same place, manager,—"Certain improvements in the method of, and in the machinery or apparatus for, preparing warps for weaving."—21st.

James Hall, Geecross, near Stockport, Chester, machine-maker,—"Certain improvements in looms for weaving."—25th.

Brereton Todd, Bank of Falmouth, gentleman,—"Improvements in the manufacture of arsenic, sulphuric acid, and the oxide of antimony from copper and other ores in which they are contained, and also the oxide of zinc."—27th.

George Gwynne, Sussex-square, Middlesex, esquire,—"Improvements in the manufacture of sugar."—27th.

Mathew Cochran, High-street, Paisley, Renfrew, North Britain, manufacturer,—"Improvements in machinery for the production and ornamenting of fabrics and tissues generally, parts of which improvements are applicable to the regulation of other machinery, and to purposes of a similar nature."—27th.

Julius Jeffreys, Bucklersbury, London, gentleman,—"Improvements in preventing or removing affections of the chest."—28th.

George Tosco Peppe, Great Marylebone-street, Middlesex, civil engineer,—"Improvements in time-keepers."—28th.

George William Lenox, Billiter-square, London, chain-cable manufacturer, and William Roberts, foreman to Messrs. Brown, Lenox, & Co., Millwall,—"Improvements in working windlass and other barrels."—28th.

Thomas Richards, William Taylor, and James Wylde the younger, of Falcon Works, Walworth, Surrey, cotton manufacturers,—"Improved rollers to be used in the manufacture of silk, cotton, woollen, and other fabrics."—March 2.

William Edwards Staite, Throgmorton-street, London, gentleman,—"Improvements in pipes for smoking, and in apparatus connected therewith."—4th.

William M'Naught, Rochdale, Lancaster, engineer,—"Certain improvements in steam-engines, and also improvements in apparatus for ascertaining and registering the power of the same."—7th.

John Fowler, jun., Melksham, Wilts, engineer,—"Improvements in draining land."—7th.

William Benson Stones, Golden-square, Middlesex, Manchester, warehouseman,—"Improvements in treating peat and other carbonaceous and ligneous matters, so as to obtain products therefrom."—(Being a communication.)—7th.

William Brown, Airdrie, Lanarkshire, electrician, and William Williams, the younger, St. Dennis, Cornwall, gentleman,—"Improvements in electric and magnetic apparatus for indicating and communicating intelligence."—7th.

Henry James Towling, Middlesex, commission agent,—"Improvements in the manufacture of fuel and manure, and deodorizing and disinfecting materials."—7th.

William Church, Birmingham, engineer,—"Certain improvements in machinery or apparatus to be employed in manufacturing cards and other articles, composed wholly or in part of paper or pasteboard, part or parts of the said machinery being applicable to printing the same, and parts to other purposes where pressure is required."—7th.

Richard Archibald Brooman, of the firm of Messrs. J. C. Robertson and Co., Fleet-street, patent agents,—"Improvements in types, stereotype plates, and other figured surfaces for printing from."—(Being a communication.)—7th.

Richard Carte, Southampton-street, Strand, Middlesex, professor of music,—"Certain improvements in the musical instruments designated flutes, clarionets, hautboys, and bassoons."—7th.

John Tayler, Manchester, mechanical designer, and Richard Hurst, Rochdale, same county, cotton-spinner,—"Certain improvements in, and applicable to looms for weaving, and in machinery or apparatus for preparing, balling, and winding warps or yarns."—7th.

Gerard John De Witte, Brook-street, Westminster, Middlesex, gentleman,—"Improvements in machinery, apparatus, metallic and other substances, for the purposes of letter-press and other printing."—(Being a communication.)—7th.

John Tebay, Hackney, Middlesex, civil engineer,—"An improved meter for registering the flow of water and other fluids."—7th.

Frederick Rosenborg, Alhemarle-street, Middlesex, Esq., and Conrad Montgomery, of the Army and Navy Club, St. James's-square, Middlesex,—"Improvements in sawing, cutting, boring, and shaping wood."—7th.

Thomas Irving Hill, Clapham, Surrey, gentleman,—"Certain improvements in the treatment of copper and other ores, and obtaining products therefrom."—9th.

Richard Holdsworth, of the firm of Holdsworth & Co., cotton-spinners, and William Holgate, engineer,—"Improvements in apparatus and machinery for warping worsted, cotton, and other fibrous materials."—11th.

William Crane Wilkins, Long-acre, Middlesex, engineer,—"Certain improvements in ventilating, heating, and lighting, in lamps and candlesticks, in the manufacture of candles, and in the apparatus to be used for such purposes."—11th.

James Nasmyth, Lille, France, engineer,—"Improvements in the method of obtaining and applying heat."—12th.

SCOTCH PATENTS.

Sealed from 22d January, to 22d February, 1850.

J. C. Robertson, Fleet-street, London, civil engineer,—"Improvements in machinery, apparatus, and processes for extracting, depurating, forming, drying, and evaporating substances."—(Communication.)—January 23.

William Thomas Henley, Clerkenwell, Middlesex, philosophical instrument maker,—"Certain improvements in telegraphic communication, and in apparatus connected therewith, part of which improvements may be also applied to the moving of other machines and machinery."—23d.

Christopher Nickels, York-road, Lambeth, Surrey, gentleman,—"Improvements in the manufacture of woollen and other fabrics."—24th.

Ewald Riepe, Finsbury-square, Middlesex, merchant,—"Improvements in the manufacture of steel."—24th.

Benjamin Thompson, Newcastle-upon-Tyne, civil engineer,—"Improvements in the manufacture of iron."—31st.

Elijah Galloway, Southampton-buildings, Chancery-lane, Middlesex, civil engineer,—"Improvements in furnaces."—February 1.

Thomas Marsden, Salford, Lancaster, machine maker,—"Improvements in machinery for hackling, combing, or dressing flax, wool, and other fibrous substances."—1st.

Robert Fayrer, Surrey-street, Strand, commander, royal navy,—"Improvements in steering apparatus."—1st.

Macgregor Laird, Birkenhead, gentleman,—"Improvements in the construction of metallic ships or vessels, or in materials for coating the bottom of iron ships or vessels, and in steering ships or vessels."—6th.

James Templeton, Glasgow, manufacturer,—"Certain improvements in manufacturing figured fabrics, principally designed for the production of carpeting."—12th.

William Henry Green, Basinghall-street, London, gentleman,—"Improvements in the preparation of peat fuel, and in the mode of applying the products derived therefrom to the preservation of certain substances which are subject to decay."—(Communication.)—12th.

Joseph Long and James Long, Little Tower-street, London, philosophical instrument makers, and Richard Pattenden, Nelson-square, Surrey, engineer,—"Improvements in instruments and machinery for steering ships, which is also applicable to vices and other instruments and machinery for obtaining power."—12th.

William Mayo, of the firm of Mayo and Warmington, Silver-street, Wood-street, Cheapside, London, manufacturers of mineral aerated waters,—"Improvements in connecting tubes and pipes, and other surfaces of glass and earthenware, and on connecting other matters with glass and earthenware."—13th.

James M'Donald, Chester, coach-maker,—"Certain improvements in the method of applying oil or grease to wheels and axles, and to machinery, and in connecting the springs of wheel carriages with the axles or axle-boxes."—13th.

Henry Attwood, Goodman's-fields, Middlesex, engineer, and John Renton, Bromley, same county, engineer,—"Certain improvements in the manufacture of starch, and other like articles of commerce, from farinaceous and leguminous substances."—14th.

William Furness, Lawton-street, Liverpool, builder,—"Improvements in machinery for cutting, tenoning, planing, moulding, dovetailing, boring, mortising, tonging, grooving, and sawing wood, also for sharpening and grinding tools or surfaces, and also in welding steel to cast-iron."—(Communication.)—15th.

Sir John MacNiell, Knight, Dublin, and Thomas Barry. Lyons, near Dublin, mechanic,—"Improvements in locomotive engines, and in the construction of railways."—15th.

Benjamin Goodfellow, Hyde, Chester, engineer,—"Certain improvements in steam-engines."—21st.

Matthew Cochran, High-street, Paisley, Renfrew, manufacturer,—"Improvements in machinery for the production and ornamenting of fabrics, and tissues generally, parts of which improvements are applicable to the regulation of other machinery, and to purposes of a similar nature."—21st.

Louis Napoleon Le Gras, Paris, Republic of France, civil engineer,—"Improvements in the separation and disinfection of fecal matters, in the manufacture of manure, and in the apparatus employed therein."—21st.

Ernest Gaston, of the Erechtheum Club, St. James's, Middlesex, gentleman,—"Improvements in artificial fuel, and in machinery used for manufacturing the same."—22d.

Auguste Reinhard, Leicester-street, Leicester-square, Middlesex, chemist,—"Improvements in preparing oils for lubricating purposes, and in apparatus for filtering oil and other liquids."—25th.

Onesiphore Pacqueur, Paris, in the Republic of France, civil engineer,—"Certain improvements in the manufacture of fishing-nets, and other net fabrics."—25th,

James Young, Manchester, Lancashire, manufacturing chemist,—"Improvements in the treatment of certain ores, and other matters containing metals, and in obtaining products therefrom."—26th.

Alfred Vincent Newton, Office for Patents, 66 Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in manufacturing leather."—(Communication.)—27th.

Eugene Ablon, Panton-street, Haymarket, Middlesex,—"Improvements in increasing the draft in chimneys of locomotive and other engines."—March 4th,

William Brown, Airdrie, Lanarkshire, electrician, and William Williams the younger, St. Dennis, Cornwall; gentleman,—"Improvements in electric and magnetic apparatus for indicating and communicating intelligence."—4th.

Alexandre Hediard, Paris, in the Republic of France, gentleman,—"Certain improvements in propelling."—5th.

Thomas Richard, William Taylor, and James Wylde the younger, all of Falcon Works, Walworth, Surrey, cotton manufacturers,—"Improved rollers, to be used in the manufacture of silk, cotton, woollen, and other fabrics."—6th.

James Hill, Stalybridge, Chester, cotton-spinner,—"Improvements in, or applicable to, certain machines for preparing, spinning, and doubling cotton, wool, and other fibrous substances."—6th.

John Fowler, Jun. of Melksham, Wilts, engineer,—"Improvements in draining land."—8th.

Gerard John De Witte, Brook-street, Westminster, Middlesex, gentleman,—"Improvements in machinery apparatus, metallic, and other substances, for the purposes of letter-press and other printing."—8th.

David Christie, St. John's Place, Broughton, Salford, Lancaster, merchant,—"Improvements in machinery for preparing, assorting, straightening, tearing, teasing, doubling, twisting, braiding, and weaving cotton, wool, and other fibrous substances."—(Communication.)—13th.

Edward Ormerod, Manchester, Lancaster, mechanical engineer, and Joseph Shepherd, Chorlton-upon-Medlock, in the same county, mechanical engineer,—"Improvements in, or applicable to, apparatus for changing the position of carriages on railways."—13th.

Frank Clark Hills, Deptford, Kent, manufacturing chemist,—"An improved mode of compressing peat for making fuel or gas, and of manufacturing gas, and of obtaining certain salts."—15th.

Warren De La Rue, Bunhill-row, Middlesex,—"Improvements in the manufacture of envelopes."—20th.

William Handley, Chiswell-street, Finsbury, confectioner, George Duncan, Battersea, Surrey, engineer, and Alexander M'Glashan, Long Acre, engineer,—"Improvements in the construction of railway breaks."—20th.

IRISH PATENTS.

Sealed from 21st January, to 19th February, 1850.

Alexander Swan, Kirkcaldy, Fife, manufacturer,—"Improvements in heating apparatus, and in applying hot and warm air to manufacturing and other purposes, when the same are required."—January 28.

Jacques Hulot, Rue St. Joseph, Paris, Republic of France, manufacturer,—"Improvements in the manufacture of the fronts of shirts."—February 1.

Thomas John Knowlys, of Heysham-tower, near Lancaster, Esq.,—"Improvements in the application and combination of mineral products, also in obtaining products from mineral and vegetable substances, and in the generation and application of heat."—4th.

Thomas Henry Russell, patent tube manufacturer, Wednesbury, and John Stephen Woolrich, Birmingham, chemist,—"Improvements in coating iron, and certain other metals and alloys of metals."—12th.

Joseph Stovel, Suffolk-place, Pall Mall, East, Middlesex, tailor,—"Improvements in coats, parts of which improvements are applicable to sleeves of other garments."—22d.

Lucien Vidie, Paris, France, now of South-street, Finsbury, French Advocate,—"Improvements in conveyances on land and water."—23d.

William Henry Phillips, York Terrace, Camberwell New Road, Surrey, engineer,—"Improvements in extinguishing fire, in the preparation of materials to be used for that purpose, and improvements to assist in saving life and property."—26th.

James Higgins, Salford, Lancaster, machine maker, and Thomas Schofield Whitworth, Salford, in the same county, mechanic,—"Certain improvements in machinery for preparing, spinning, and doubling cotton, wool, flax, and similar fibrous materials."—26th.

Auguste Reinhard, Leicester-street, Leicester-square, Middlesex, chemist,—"Improvements in preparing oils for lubricating purposes, and in apparatus for filtering oil and other liquids."—26th.

Oncsiphore Pacqueur, Paris, civil engineer,—"Certain improvements in the manufacture of fishing-nets, and other net fabrics."—27th.

Ernest Gaston, Erechtheum Club, St. James's, Middlesex,—"Certain improvements in artificial fuel, and in machinery used for manufacturing the same."—March 1st.

Alexandre Hediard, Paris, Republic of France, gentleman,—"Certain improvements in propelling."—5th.

Alfred Vincent Newton, Office of Patents, 66 Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in manufacturing leather."—6th.

Thomas Marsden, Salford, Lancashire, machine maker,—"Improvements in machinery for hackling, combing, or dressing flax, wool, and other fibrous substances."—8th.

Henry Attwood, Goodman's Field, Middlesex, civil engineer, and John Renton, Bromley, in the same county,—"Certain improvements in the manufacture of starch, and other like articles of commerce, from farinaceous and leguminous substances."—12th.

James M'Donald, Chester, coachmaker,—"Certain improvements in the method of applying oil or grease to wheels and axles, and to machinery, and in connecting the springs of wheel carriages with the axles or axle-box."—15th.

James Hill, Stalybridge, Cheshire,—"Improvements in, and applicable to, certain machines for preparing, spinning, and doubling cotton, wool, and other fibrous substances."—16th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 14th February, to 13th March, 1850.

Feb. 15th,	No. 2187.	Samuel Hiron, Birmingham,—"Press for embossing and other purposes."
16th,	2188.	Thomas Wells Cross, Leeds,—"Barrel with grooved and tongued staves."
18th,	2189.	Anthony Mayer, Savave Gardens, Tower Hill,—"Sawing instrument."
20th,	2190.	John Sanders, Wood-street, Cheapside,—"An umbrella tent."
21st,	2191.	John Broadfoot, Glasgow,—"Water-closet valves."
22d,	2192.	William Simons, Greenock,—"Telescopic tiller."
—	2193.	David Stephens Brown, Old Kent-road,—"Thermo-barometer."
—	2194.	Thomas Warren, Oxford-street,—"Reading-stand."
—	2195.	Joseph Wood, York,—"Razor."
23d,	2196.	E. Moses and Son, Aldgate and Minories,—"Strap for trousers."
—	2197.	William Hancock, Cross-street, Islington,—"Elastic safety-pocket or garde-poche."
25th,	2198.	William Williams and Samuel L. Taylor, Bedford,—"Improved chaff-cutter."
—	2199.	Luke Marshall Hill, Whitby,—"The 'Habit Unique.'"
—	2200.	David Stephens Brown, Old Kent-road,—"Hinged label."
—	2201.	Biffon and Son, Hammersmith,—"Portable wager-boat."
—	2202.	Alexander Symons and Alexis Soyer, carrying on business under the firm of A. Soyer and Co., Charing-cross,—"Magic stove."
—	2203.	Thomas Nixon, Kettering,—"Metallic ventilating skylight, or garden sash-frame."
27th,	2204.	James Tyson Nibbs, Baslow, Chesterfield,—"The oxydate condensing lamp."
March 1st,	2205.	R. W. Winfield, Birmingham,—"Sacking for metallic bedstead."
—	2206.	Robert Harris, Braunston, Northamptonshire,—"The annular cultivator."
—	2207.	Nath. Clissold Fluck, Gloucester,—"Pattern-cutting machine."
2d,	2208.	Smiths & Co., Edinburgh,—"Wick elevator."
—	2209.	James Firth, Belfast,—"Fire-bar for locomotive and other furnaces."
—	2210.	James Moon, Malton, Yorkshire,—"Chimney cap."
4th,	2211.	John Sweet Willway, Denmark-street, Bristol,—"Phero-pneuma, or gas-carrier."
5th,	2212.	Edwin John Vickery, Great Dover-road, Borough,—"Merino-bodied hat."
—	2213.	James Thomas Woodman, Walton-on-Thames,—"Leg and foot rest."
—	2214.	William George Barker, Old Cavendish-street,—"An elastic opening to be inserted in boots or shoes."
—	2215.	William Johnson, Farnworth, Lancashire,—"Lubricator."
6th,	2216.	The Rev. Authony Singleton Atcheson, rector of Teigh, Rutland,—"Writing, travelling, or invalid's table."
7th,	2217.	Samuel Sheppard, Birmingham,—"Pump with draught and stop-cock."
—	2218.	J. & C. Clark, Wolverhampton,—"Coffee-mill."
—	2219.	Joseph Gardner, Birmingham,—"Invalid's supporter, or bed-rest."
11th,	2220.	Samuel Sharpe & Co., Vauxhall,—"An implement for distributing and sowing seed, and for a strickle or tool for regulating the quantity of seed in the said implement."
—	2221.	Deane, Dray, and Deane, King William-street,—"Railway break."
12th,	2222.	Thomas Waddington, Manchester,—"A self-adjusting clip for gaiters and leggings."
—	2223.	Richard Harris and Sons, Leicester,—"A polka."
—	2224.	Thomas John Marshall, Bishopsgate-street Without,—"Dandy roller for letter and note paper."

TO READERS AND CORRESPONDENTS.

Volumes I. and II. of the *Practical Mechanic's Journal* are now completed, and may be had from any bookseller, in cloth and lettered, price 14s. each. Vol. I. contains 292 pages quarto, with 26 large engravings on copper, and 215 engravings on wood. Vol. II. contains 292 pages, with 18 engravings on copper, and 277 engravings on wood, and both volumes are furnished with copious indices in addition. Cloth covers, lettered in gold, may be obtained separately at 1s. 6d. each. Subscribers may have their parts done up in these covers for 2s. each.

HACKWORTH'S LOCOMOTIVE PASSENGER ENGINE "SANSPAREIL."—The descriptive matter to accompany the plates of this engine, will commence in the May number, with the plates which we have announced on the cover.

A. B. C., Manchester.—His question is much too important to be answered in the brief space we can devote to it here. "Hints to Inventors" may be obtained direct from our office, as elsewhere announced,

W. A., London.—We have received his reply, and must refer him to our former communication. The case furnished was not intended to meet that of his engine, but to show him that he has mistaken the office of the "constant number."

J. G. H., Leith.—We have previously given a general notice of this invention; and, indeed, its ingenuity has now brought it into such well-deserved favour, that an illustration of it would be superfluous.

Mr. KIRKPATRICK.—His sketch has been drawn for the engraver, and will appear next month.

T, P., New York.—We have received his letter of the 5th March, with his enclosure. The drawings are now engraving, and the article will appear next month. We shall be glad of his continuation.

J. T.—We are obliged by his enclosure, which we hope to turn to good account in our own practice.

G. O., Greenwich.—Is he serious? We hope not, for we never before met with such a piece of nonsense. We will give him our reasons for thinking so next month, if he likes.

J. S.—The drawings and description have been received, and will appear next month.

J. S., Bristol.—We are also favoured with his contribution, too late, however, for the present number,

A. S, A., Rutland.—We shall be glad to find room for him in our May number.

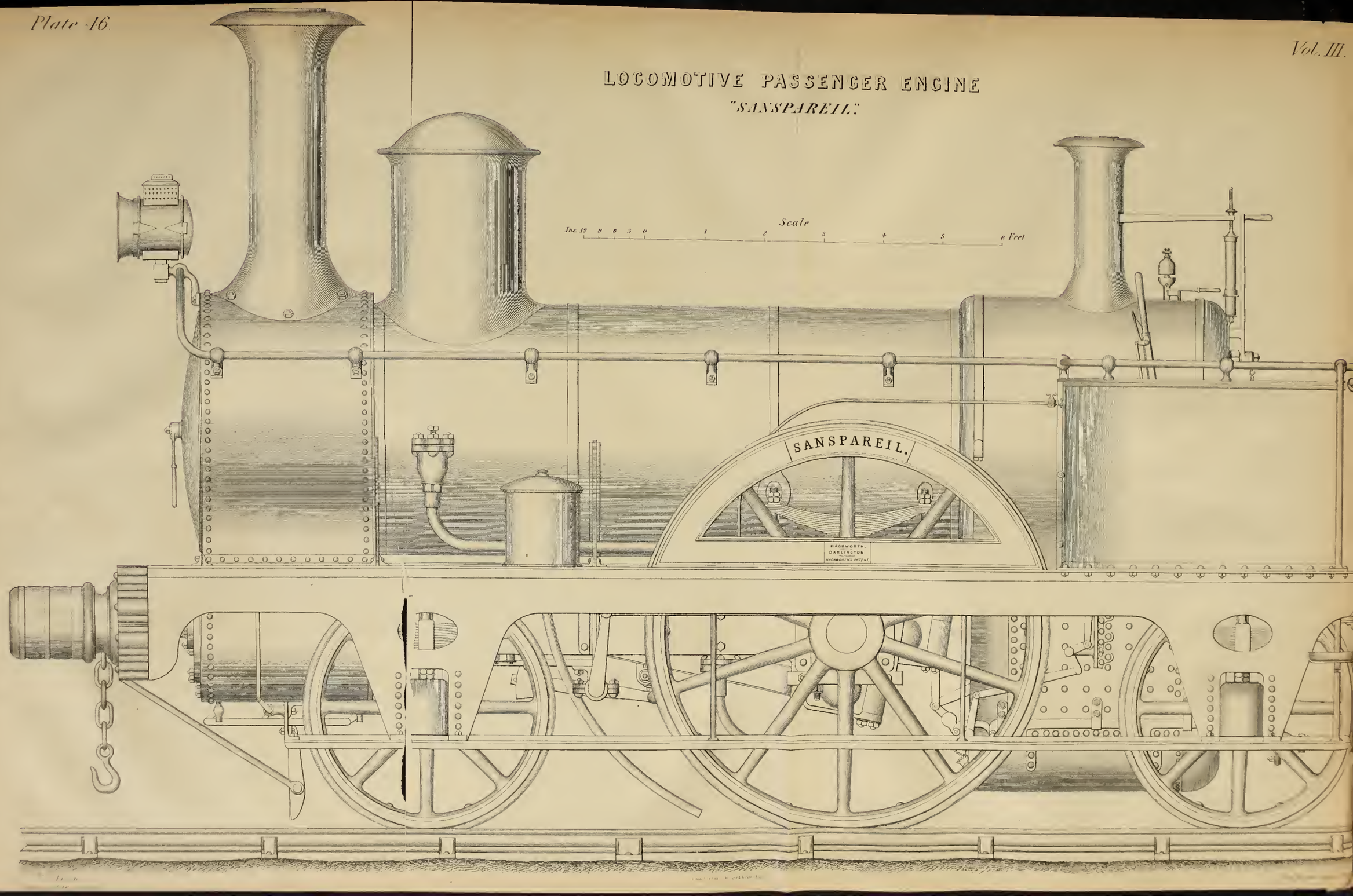
T. P., Romsey.—We are afraid we cannot congratulate our correspondent on his invention, We may give him our opinion upon it next month.

T. N., Kettering.—We have engraved one of his sketches in readiness for Part 26.

DR. HENDERSON'S PLANETARIUM.—We are obliged by our correspondent's attentions, and shall make use of his contribution.

LOCOMOTIVE PASSENGER ENGINE

"SANSPAREIL."



SENGER ENGINE

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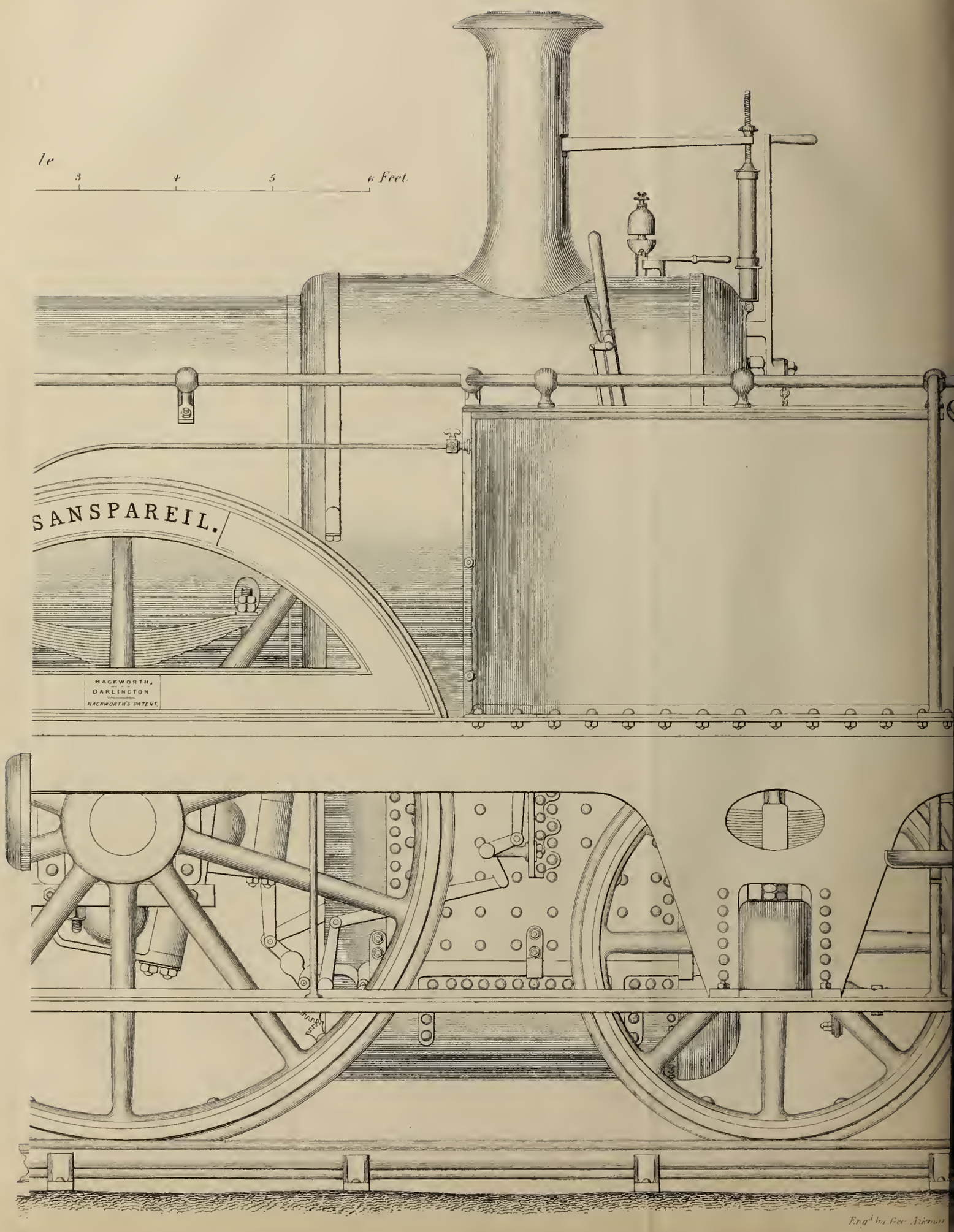
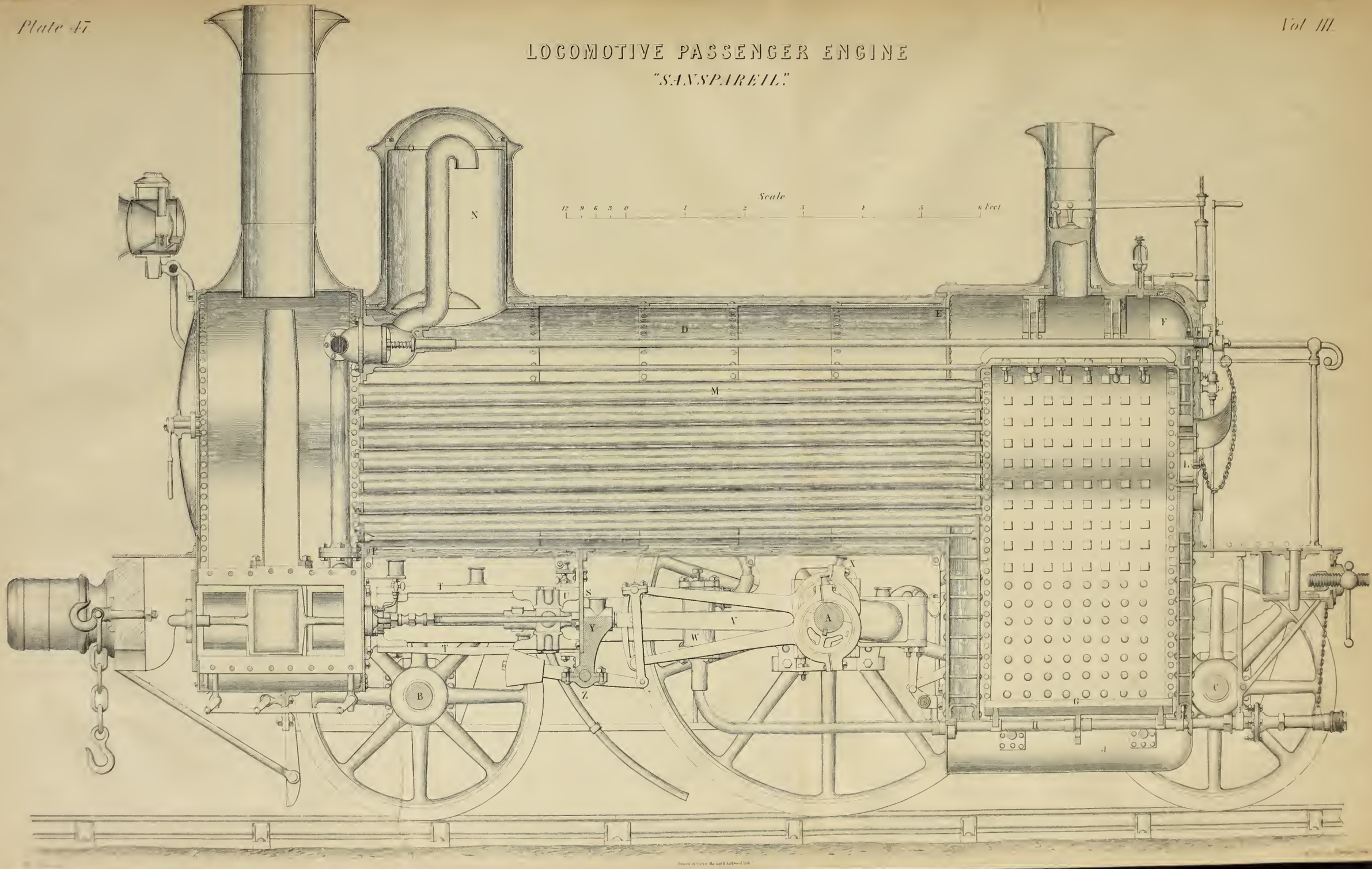


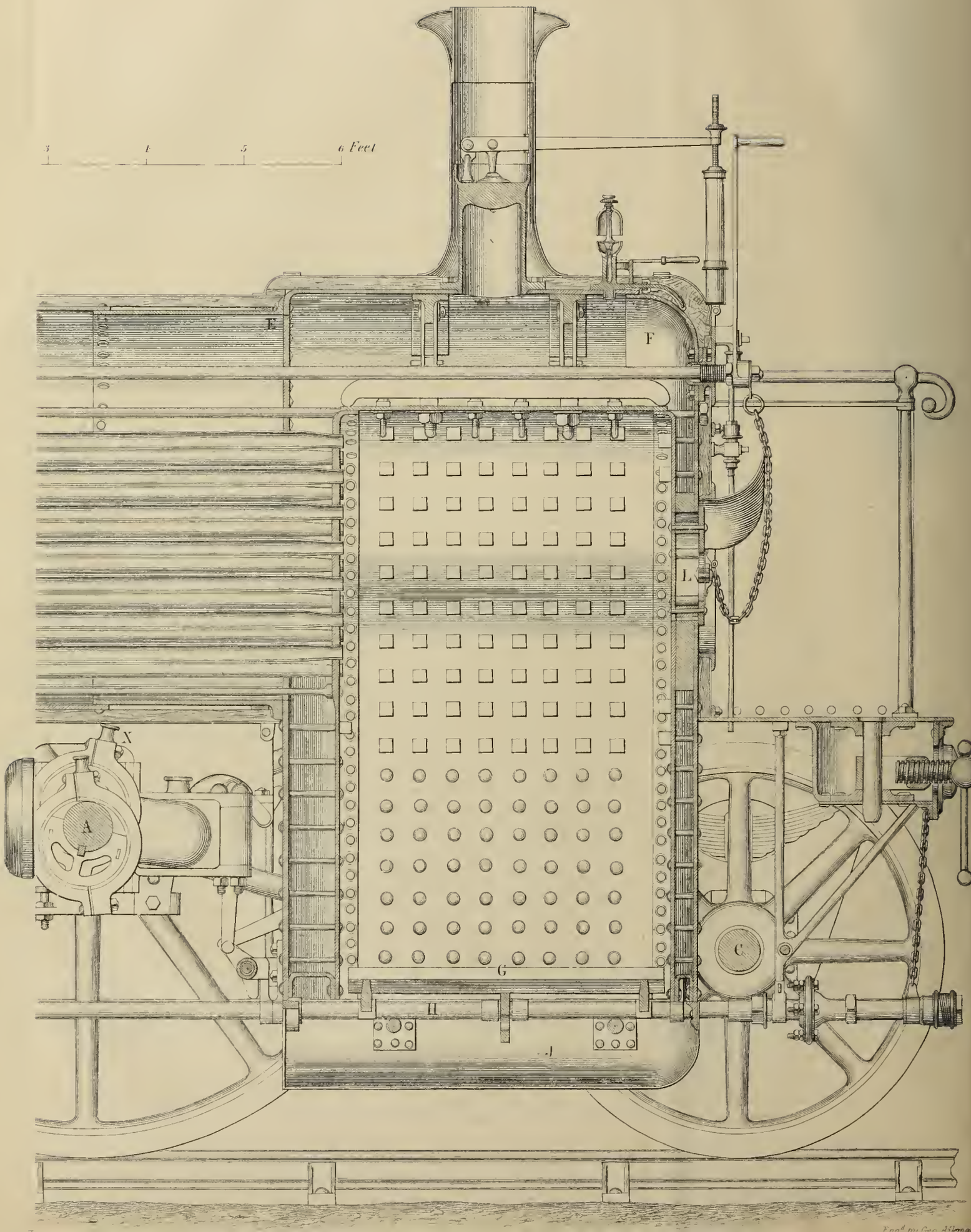
Engd by Geo. Aikman

LOCOMOTIVE PASSENGER ENGINE

"SANSPAREIL."



R ENGINE



LOCOMOTIVE PASSENGER-ENGINE "SANSPAREIL."

(Illustrated by Plates 46 and 47.)

The early history of steam-locomotion holds an important place in the pages of the romance of mechanical discovery, to the interest of which Mr. Hackworth, the maker of our present example of the results of modern practice, in this department, has very extensively contributed. In 1829 we find him coming forward as a stout competitor for the £500 prize offered by the Directors of the Liverpool and Manchester Railway, with a locomotive, built under the then stringent conditions of drawing three times its own weight, which was not to exceed six tons, on a plane, at the rate of ten miles an hour. Now, in 1850, he comes before us with his accumulations of experience in the shape of an engine, weighing over twenty-three tons, and powerful enough to walk away with some hundred tons of dead weight, while she has repeatedly come up to the speed of seventy-five miles an hour. The regular daily work performed by engines of the same class in our own day, forms a curious contrast to the early locomotive efforts of the time when Mr. Hackworth played his part in the game of locomotive racing, and teaches an instructive lesson on the gradual development of mechanical invention.

Certainly no other department of engineering has so well exhibited the slowly progressive advance of genius towards the perfection of a single idea, for whilst many other branches of constructive art have long stood comparatively unaltered, the locomotive is coustantly being remodelled and amended. It is then barely possible, out of the multitudinous systems of arrangement, to select one example which may be fitly considered as the model of the day; but, in carrying out our design of displaying whatever is good in mechanism and practical science, we must supply models in variety, and thus endeavour to obtain a balance of the defects and excellencies from the mass. With such an understanding, we need scarcely waste more words in the introduction of an engine made by a practician of Mr. Hackworth's experience—an experience, indeed, coeval with railways themselves.

The "Sanspareil," which perpetuates the name of the Liverpool trial engine from the same hands, has been built at the Soho Engine Works, near Darlington, by Mr. Timothy Hackworth, from the designs of his son, Mr. J. W. Hackworth, who inherits a large share of his father's engineering abilities. In our number 25, for April last, we have given, in plate 46, a complete external elevation of the engine; and this month we present, in plate 47, a corresponding longitudinal section.

She has been expressly designed for fast passenger trains, having driving wheels 6 feet 6 inches diameter, with leading and hind wheels of 4 feet diameter. Her weight, in working order, is 23 tons, 15 cwt., and this is distributed in the following manner: on leading wheels, 8 tons, 6 cwt.; drivers, 11 tons, 4 cwt.; and hind wheels, 4 tons, 5 cwt.

The crank axle, A, is carried in bearings in the inner frame, whilst those of the leading and hind wheels, B and C, are in the outer frame, the length from centre to centre of the latter pairs being 13 feet 6 inches; these proportions having been laid down with a strict reference to the stability of the leading wheels, without an undue detraction from the tractive adhesion of the drivers. The barrel, D, of the boiler, presents the novelty of welded longitudinal seams, which we lately noticed in our account of "Willis' Farmer's Engine." It is composed of five plates, turned into rings, each being welded longitudinally, whilst their transverse junctions, one with another, are riveted in the ordinary way. The junctions, E E, of the two ends, with fire-box and smoke-box, are formed by angles or flanges welded on, instead of by separate angle irons riveted. These were turned and faced in the lathe to a true surface, for the bearing against the fire-box at one end, and the cylinder foundation plate at the other, thus affording great accuracy of connection in these details. The original idea of welding the boiler-plates is claimed by Mr. Hackworth, who, it appears, had actually made a boiler on this principle, long prior to the date of the construction of the "Farmer's Engine" by Mr. Willis. The example of this construction now before us, is a very beautiful one; indeed, it is unrivalled as a specimen of this class of workmanship. The lagging or cleading of the boiler is covered with sheet-iron, giving the surface that smooth appearance, as shown in the elevation, plate 46.

The plate, F, forming the back corners of the fire-box, is 14 inches broad, and was originally made in three pieces, for the convenience of setting; but, after the completion of the process, they were welded together, so as to form a single plate.

The grate bars, G, are arranged longitudinally, and are carried on two transverse bearers, supported on projections on a pair of longitudinal shafts, H H, at the bottom of the fire-box, and worked by a lever, I, standing up from the foot-plate, so that the driver may drop the whole set of bars, instantaneously, into the ash-box, J. The latter may also be dropped independently of the bars, by releasing the suspending bars, K K, on each side.

The fire-door, L, is provided with a regulator for the admission of air into the fire-box at pleasure, the baffle-plate being perforated with small apertures for its dissemination in the interior. The boiler tubes, M, are of brass, 2 inches in external diameter, and are 221 in number. At the smoke-box end of the tubes, a baffle-plate is also fixed opposite the tube ends. It is perforated with holes $1\frac{1}{8}$ inch diameter, the under sides of which correspond with the bottom line of the tubes, so that the hotter portion of the vapour is retained at the upper side, inducing a superior evaporative action. This addition does not interfere in any way with the cleaning of the tubes, as it may be removed with great facility. The dome, or steam chest, N, is formed out of a single plate, welded longitudinally, the flange for riveting it to the boiler being worked out of the same plate. The upper flange at O, is welded on internally, being turned and faced to form a steam-tight joint with the convex cover, which is similarly formed, and is removable for obtaining access to the boiler.

The pistons, P, also involve some novelties both in design and construction. They are made entirely of wrought-iron, with the rods forged on them, so that, whilst there is thus a gain in lightness and strength, the dangers resulting from occasional looseness are completely removed. The inner framing, Q, consists of two wrought-iron slabs extending the whole length of the boiler's barrel, and attached at one end to the fire-box, by $\frac{5}{8}$ inch angular plates riveted on. The peculiar advantage of this arrangement of frame is, that it yields to the expansion and contraction of the boiler, preserving a constantly uniform length between the cylinder and crank axle, and obviating the very common tendency to work loose, and cause leakage. The frame plates extend from the centre of the crank axle, so as to counteract the effect of the strain of the engine at the most effective point, and a stiff connection is formed with the barrel of the boiler, by a strong central transverse plate, riveted on by means of stirrup angle irons. At the smoke-box end, a foot, or flange, is formed on each frame plate, for abutting against the tube plate, to which it is riveted and bolted, the connections being passed through the cylinder flanges.

The outer framing, R, consists of a wrought-iron slab, 9 inches deep, and 1 inch thick, extending the whole length between the buffer bars, the axle guards being forged in one piece with it. The transverse junction plate, S, forms a very important feature of the engine; it is riveted to the boiler by double angle irons, and extends across and between the inner and outer frame plates, forming an effective fixed point for the pressure of the working gear.

The piston-rod motion consists of a pair of steel slide bars, T T, attached at one end to protecting flanges cast on the cylinder cover, and at the other, to the transverse junction plate, S. The cross-heads, or motion blocks, U, each consist of a malleable iron double eyepiece, with a box at the inner end, into which the piston-rod is keyed; and on the upper and lower sides of the double eye, are bolted the brass slides, with projecting flanges to guide them on the motion bars.

The connecting-rods, v, are of a plain rectangular section, and are attached to the cross-heads by a steel pin passing through them, and through the double eyes, secured by a nut on the outside.

The feed-pumps are placed in a line parallel with the piston-rods. The rams are of malleable iron, passed through and secured by a nut to the cross-head pin. The pumps are of brass; they are attached to the inner frame, and transverse junction plate.

It is an ascertained fact that, in too many cases, very little regard is paid to the obtainment of a sufficient area in the valve cases for the admission of feed water to the boiler. Owing to the contraction of this space, the valves are made of small size, and thus a great rise is absolutely necessary to admit a due supply of water; and this, coupled with their great rapidity of action, is frequently the occasion of great inconvenience in point of derangement and wear. Where the contraction exists in excess, the defect is heightened by the absorption of power in forcing the feed through the passages.

In the "Sanspareil," the valves and valve boxes, w, are made very large, so as only to require $\frac{1}{8}$th inch lift of valve.

The eccentric sheaves are made with the smaller divisions of wrought iron, having pins forged upon them, to connect them with the larger or prominent eccentric sides, which are of cast-iron. The eccentric rods and straps are of wrought-iron, and the rods are forged on the front halves of the straps, the latter being lined with brass. The back halves have an oil vase, x, forged on each, with a siphon pipe on each side the bolt, for lubricating the sheave. The slide spindles are guided in brass bearings, in a bracket, y, fixed to the transverse junction plate, and the bottom of this bracket, at z, forms a bearing for one end of the reversing weigh bar.

The ordinary link motion is adopted for the slide and reversing gear, the lifting links for reversing being placed inside the motion links, and connected with the forward eccentric pins, and the levers on the reversing weigh bar are forged on.

Additional engravings of this engine are in preparation; with these, which will give very full details of construction, we shall furnish some particulars of the engine's performance.

IRON FOR RAILWAY STRUCTURES.

REPORT OF THE COMMISSIONERS APPOINTED TO INQUIRE INTO THE APPLICATION OF IRON TO RAILWAY STRUCTURES.

(Concluded from Page 11.)

We also made some experiments by means of the large apparatus, before mentioned, on curved bars, and these bore much greater weights at high velocities than straight bars; but the deflections of these bars were very great, compared with their length. In drawing attention to these experiments, we would remark that, in actual structures, where the deflections are so very small, the effect of cambering the girders, or of forming a curved pathway for the load, would be of less comparative importance, and might tend to introduce practical inconvenience.

The general impression amongst engineers appears to be at variance with the above results. They, for the most part, state their belief that the deflection caused by passing a weight at a high velocity over a girder is less than the deflection which would be produced by the same weight at rest; even when they have observed an increase, they have attributed it solely to the jerks of the engine, or train, produced by passing over inequalities at the junction of the rails, or other similar causes.

For the purpose of examining this question, we have submitted two actual bridges to the test of experiment. These bridges, one of which, the Ewell Bridge, is situated upon the Croydon and Epsom line, and the other, the Godstone Bridge, upon the South Eastern line, are both constructed to carry the railway over a road. A scaffold was constructed, which rested on the road, and was, therefore, unaffected by the motion of the bridge, and a pencil was fixed to the under side of one of the girders of the bridge, so that when the latter was deflected by the weight of the engine, or train, either placed at rest or passing over it, the pencil traced the extent of deflection upon a drawing-board attached to the scaffold. An engine and tender, which had been in each case liberally placed under our orders by the directors of the companies, was made to traverse the bridges at different velocities, or rest upon them at pleasure. The span of the Ewell Bridge is 48 feet, and the statical deflection due to the above load rather more than one-fifth of an inch. This was slightly but decidedly increased when the engine was made to pass over the bridge, and at a velocity of about 50 miles per hour, an increase of one-seventh was observed. As it is known that the strain upon a girder is nearly proportional to the deflection, it must be inferred that in this case the velocity of the load enabled it to exercise the same pressure as if it had been increased by one-seventh, and placed at rest upon the centre of the bridge. The weight of the engine and tender was 39 tons, and the velocity enabled it to exercise a pressure upon the girder equal to a weight of about 45 tons. Similar results were obtained from the Godstone Bridge. We would take this opportunity of mentioning how much we are indebted to Mr. P. W. Barlow and to Mr. Hood for the assistance they afforded us in making these experiments.

We have also to express our obligations to the Astronomer Royal for the advantage of his presence during the above and other experiments, as well as for many valuable suggestions during the progress of the inquiry.

In addition to the above experiments, we have made many for the purpose of supplying data for completing the mechanical theory of elastic beams. If a beam be in any manner bent, its concave side will be compressed, and its convex side extended. An exact knowledge of the laws which govern its compression and extension must precede any accurate general theory of its deflections, vibrations, and ruptures.

The law which is usually assumed in mathematical investigations, and by which the longitudinal compressions and extensions, within certain limits, are assumed to be directly proportional to the forces by which they are produced, although very nearly true in some bodies, is not, perhaps, accurately true for any material.

Experiments have, therefore, been made to determine with precision the direct longitudinal extension and compression of long bars of cast and wrought iron. The extensions were determined by attaching a bar, 50 feet in length and 1 inch square, to the roof of a lofty building, and suspending weights to its lower extremity.

The compressions were ascertained by enclosing a bar 10 feet long and 1 inch square in a groove, placed in a cast-iron frame, which allowed the bar to slide freely without friction, and yet permitted no lateral flexure. The bar was then compressed by means of a lever, loaded with various weights. Every possible precaution was taken to insure accuracy. The following formulæ were deduced for expressing the relation between the extension and compression of a bar of cast-iron, 10 feet long and 1 inch square, and the weights producing them respectively:—

Extension, $w = 116117e - 201905e^2$

Compression, $w = 107763d - 36318d^2$.

Where w is the weight in pounds acting upon the bar, e the extension, and d the compression in inches.

And the formulæ deduced from these, for a bar 1 inch square and of any length, are—

For Extension, $$w = 13934040\,\frac{e}{l} - 2907432000\,\frac{e^2}{l^2}$$

For Compression, $$w = 12931560\,\frac{d}{l} - 522979200\,\frac{d^2}{l^2}.$$

Where l is the length of the bar in inches.

These formulæ were obtained from the mean results of four kinds of cast-iron.

The mean tensile strength of cast-iron derived from these experiments is 15,711 lbs. per square inch, and the ultimate extension $\frac{1}{60}$ of the length, and this weight would compress a bar of iron of the same section $\frac{1}{775}$ of its length. It must be observed, that the usual law is very nearly true for wrought-iron.

Many denominations of cast-iron have got into common use, of which the properties have not yet been ascertained with due precision. Seventeen kinds of them have been selected, and their tensile and crushing forces determined. Experiments have also been made upon the transverse strength and resistance of bars of wrought and cast-iron acted upon by horizontal as well as vertical forces. These experiments will be found to exhibit very fully the deflections and sets of cast-iron and the defect of its elasticity.

The bars which were experimented upon by transverse pressure, were of sections varying from 1 inch square to 3 inches square, and of various other sections, and the actual breaking weights show that the strength of a bar 1 inch square should not be taken as the unit for calculating the strength of a larger casting of similar metal, although the practice of doing so has been a prevalent one, for it appears that the crystals in the portion of the bar which cools first, are small and close, whilst the central portion of bars 2 inches square, and 3 inches square, is composed

of comparatively large crystals, and bars of 3 inches square in section planed down on all sides alike to ¾ of an inch square, are found to be very weak to resist both transverse and crushing pressure. Hence it appears desirable in seeking for a unit for the strength of iron of which a large casting is to be made, that the bar used should equal in thickness the thickest part of the proposed casting.

The performance of these various experiments has been greatly facilitated by the permission which was liberally granted to us by the Lords Commissioners of the Admiralty, to make use of Portsmouth Dockyard in carrying on our investigations, in addition to which, however, we found it necessary to hire for several months some premises in Lambeth. This was found requisite for the performance of those portions of the experimental inquiry which had been undertaken by Eaton Hodgkinson, Esq. Although we are aware, that to point out the labours of individual members of the Commission would be impossible, and that it may appear invidious to single one out for praise, we cannot resist the expression of our thanks to the above-named gentleman for the zeal and intelligence with which he has carried out the remarkable series of experiments which are detailed in the Appendix to this Report, and which constitute a large proportion of those which have been already described.

In addition, we have obtained, from many of the iron-masters, information respecting the various processes employed by them in the manufacture of their irons, and the effect of such processes upon the strength and properties of the material produced; and we have also made careful inquiries of civil engineers with respect to the qualities and mixtures of iron preferred by them, for the large castings used in the construction of railway bridges, and to the respective properties of hot-blast and cold-blast iron; this investigation has been greatly facilitated by the liberality and candour with which these gentlemen have communicated to us the results of their experience.

As no map of the kingdom had been constructed representing the districts in which iron is found and worked, we applied to the officers of the Museum of Practical Geology for their assistance, and they caused one to be prepared expressly to accompany this Report, in which the principal furnaces now in blast are shown.

Great differences of opinion exist with respect to the best qualities and mixtures of iron; and, after all, it appears that those employed for large castings depend practically so much upon the commercial question of relative cost, that engineers are rarely able to select the very best material. It is generally admitted that engineers have no guarantee that the mixture for which they have stipulated in a contract shall be that used by the founder, and no certain test by which to determine whether a given piece of iron has been manufactured by hot or cold blast. A very good protection appears to be contained in the recommendation of Mr. Fox, that engineers, in contracting for a number of girders, should stipulate that they should not break with less than a certain weight (leaving the mixture to the founder), and cause one more than the required number to be cast. The engineer may then select one to be broken, and, if it break with less weight than that agreed upon, the whole may be rejected.

At the beginning of the railway system the bridges were naturally constructed upon similar principles to those which had been already employed for common roads or aqueducts. Some of these ordinary constructions have proved inadequate to sustain the enormous loads and vibrations of railway trains. Some have been considered too expensive; others, as the suspension bridges, have been found wholly unfitted for railway purposes. Moreover, the necessity for preserving the level of a railroad as much as possible, combined with that of passing under or over existing canals, rivers, or roads, has created a demand for those forms of bridges which admit of being kept as low as possible, consistently with the proper headway or passage below; or, in other words, of making the least possible difference of level between the road or stream which the bridge has to carry and that which it has to cross.

From these causes, combined with the innumerable opportunities of building new bridges which the railways have given occasion to, and a constant endeavour to reduce the expense of building them, a variety of new constructions have been proposed and essayed, most of them of great merit and value, while others appear to be of very doubtful stability.

On the whole, the art of railway bridge-building cannot be said to be in that settled state which would enable an engineer to apply principles with confidence. We have therefore thought it our duty to inquire into the present methods of railway bridge-building, to collect in evidence the opinions and practice of the leading members of the profession of civil engineers upon this branch of construction, and especially with respect to the form and proportions of simple cast-iron girders, the practical limits to the employment of such girders, the methods of combining them with the rest of the structure, the various forms of compound girders, the expediency of several combinations of wrought-iron with cast-iron: and, finally, the comparative merits of plain girders, and of other forms in which the principles of the arch, or other methods of giving stiffness, are introduced.

The simplest bridge, and that which admits of the greatest possible headway at a given elevation, is, undoubtedly, the straight girder bridge.

The length of a simple cast-iron girder appears to be limited only by the power of making sound castings, and the difficulty of moving large masses. Thus the practical length has been variously stated to us as 40, 50, and 60 feet. The form resulting from Mr. Hodgkinson's former experiments on this subject is universally admitted to be that which gives the greatest strength; but the requirements of construction compel many variations from it, especially in the ratio between the top and bottom flanges. Moreover, the convenience and the necessity of keeping the roadway for rails as low as possible has introduced a practice of supporting the beams which sustain the rails upon one side of the bottom flange. The pressure of the roadway and of the passing loads being thus thrown wholly on one side of the central vertical web of the girder produces torsion (which is not always taken into account in determining the proportions of the girder). The existence of this torsion is admitted on all hands, and various schemes are employed to counteract and diminish it; but the form of a girder that will effectually resist this disturbing force, without incurring other evils, still remains a desideratum.

The requisite length of girders is increased considerably by the excessive use of skew bridges; and it is much to be regretted that difficulties should often be thrown in the way of altering the course of existing roads and canals when the line of a proposed railway happens to cross them at an acute angle. Partly from these causes, and partly from a little indulgence in the pride of construction, skew bridges may be found, of which, from the obliquity of the bridge, the girders are more than double the length that would be required by the direct span for the opening to be crossed.

When the span of the opening or other circumstances render the use of single straight girders unadvisable, straight girders built up of several separate castings bolted together, and sometimes trussed with wrought-iron tension rods, are largely employed, and necessarily with great varieties of construction. By these means the girders may be extended to spans of upwards of 120 feet.

When wrought-iron is combined with cast-iron in the manner of trussing, several difficulties arise from the different expansions of the two metals and the difference of their masses, which causes the wrought-iron rods to be more rapidly affected by a sudden change of temperature than the cast-iron parts. The constant strain upon the wrought-iron tends to produce a permanent elongation, and hence tension-rods may require to be occasionally screwed up. We have sought for opinions and information upon all these questions, and these show that the greatest skill and caution are necessary to insure the safe employment of such combinations. It is not admitted that the vibration of railway trains would loosen or injure the bolts or rivets of compound girders. Nevertheless, wood, felt, or other similar substances have occasionally been introduced between surfaces to diminish the communication of vibration.

The general opinion of engineers appears to be, that the cast-iron arch is the best form for an iron bridge when it can be selected without regard to expense, or to the height above the river or road which is to be crossed. For low bridges the bowstring girder is recommended. Lattice bridges appear to be of doubtful merit.

The latest mode of construction that has been introduced consists of boiler plates riveted together as in iron ship-building, and combined in various ways with cast-iron. Hollow girders are thus formed, which are either made so large as to admit of the road and carriages passing through them, as in the Conway and Britannia bridges, or else these tube girders are made on a smaller scale, and employed in the same manner as the ordinary cast-iron girders, to sustain transverse joists which carry the road. The first kind is applicable to enormous spans, those of the two bridges above mentioned being 400 and 462 feet respectively. The second kind are said to be cheaper and more elastic than other forms for spans that exceed 40 feet. These methods appear to possess and to promise many advantages, but they are of such recent introduction that no experience has yet been acquired of their powers to resist the various actions of sudden changes of temperature, vibrations, and other causes of deterioration. We have thought it our duty to seek for information with respect to them, and we find engineers to be for the most part exceedingly favourable towards them; but for the reasons above stated, we are unable to express any opinion upon them. At the same time we desire to bear testimony to the patient care and scientific manner in which the forms and proportions of the great tubes of the Conway and Britannia bridges have been elaborated; and we must

beg to refer to the Minutes of Evidence for the details of the information which we have collected.

The investigation in which we have been concerned, has made it evident that the novelty of the railway system has introduced a variety of new mechanical causes, the effects of which have not yet had time fully to develop themselves, on account of the extent and number of new railways, and the rapidity with which they were constructed, in many cases scarcely giving breathing time to the engineers, by which to observe and profit by the experience of each successive new construction. Thus it has happened that some portions of mechanism and structure have been made too weak, or placed in unfavourable combinations; and hence some unavoidable but most lamentable, and sometimes fatal accidents have been occasioned. It also appears that there exists a great want of uniformity in practice in many most important matters relating to railway engineering, which shows how imperfect and deficient it yet is in leading principles.

But we have also observed throughout the present inquiry, that the engineers have been already warned by experience of the necessity for increasing the strength of bridges employed in railways; and of watching more narrowly their construction, so as to render them as strong as possible. Accordingly we have found that the original structure of all those bridges which had shown the least signs of weakness, has been carefully altered and strengthened, so as to leave no apparent cause for apprehension; while in new bridges, better and stronger combinations are adopted.

And in conclusion, considering that the attention of engineers has been sufficiently awakened to the necessity of providing a superabundant strength in railway structures, and also considering the great importance of leaving the genius of scientific men unfettered for the development of a subject as yet so novel and so rapidly progressive as the construction of railways, we are of opinion that any legislative enactments with respect to the forms and proportions of the iron structures employed therein would be highly inexpedient.

We would, however, direct attention to the general conclusions we have arrived at from our own experiments and from the information supplied to us, namely,—

That it appears advisable for engineers in contracting for castings to stipulate for iron to bear a certain weight, instead of endeavouring to procure a specified mixture.

That to calculate the strength of a particular iron for large castings, the bars used as a unit should be equal in thickness to the thickest part of the proposed casting.

That, as it has been shown that to resist the effects of reiterated flexure iron should scarcely be allowed to suffer a deflection equal to one-third of its ultimate deflection, and since the deflection produced by a given load is increased by the effects of percussion, it is advisable that the greatest load in railway bridges should in no case exceed one-sixth of the weight which would break the beam when laid on at rest in the centre.

That, as it has appeared that the effect of velocity communicated to a load is to increase the deflection that it would produce if set at rest upon the bridge—also, that the dynamical increase in bridges of less than 40 feet in length is of sufficient importance to demand attention, and may even for lengths of 20 feet become more than one-half of the statical deflection at high velocities, but can be diminished by increasing the stiffness of the bridge,—it is advisable that, for short bridges especially, the increased deflection should be calculated from the greatest load and highest velocity to which the bridge may be liable; and that a weight which would statically produce the same deflection should, in estimating the strength of the structure, be considered as the greatest load to which the bridge is subject.

Lastly, the power of a beam to resist impact varies with the mass of the beam, the striking body being the same, and by increasing the inertia of the beam without adding to its strength, the power to resist impact is within certain limits also increased. Hence it follows, that weight is an important consideration in structures exposed to concussions.

Whilst, however, we lament that the limited means which have been placed at our disposal, and the great time required for such investigations, have compelled us to leave in an imperfect state, or even to neglect altogether, many interesting and important branches of experimental inquiry, we trust that the facts and opinions which we have been enabled to collect, will serve to illustrate the action which takes place under varying circumstances in iron railway bridges, and enable the engineer and mechanic to apply the metal with more confidence than heretofore.

Whitehall, 26th July, 1849.

WROTTESLEY.
ROBERT WILLIS.
HENRY JAMES.
GEORGE RENNIE.
W. CUBITT.
EATON HODGKINSON.

DOUGLAS GALTON,
Lieut. Royal Engineers, Secretary.

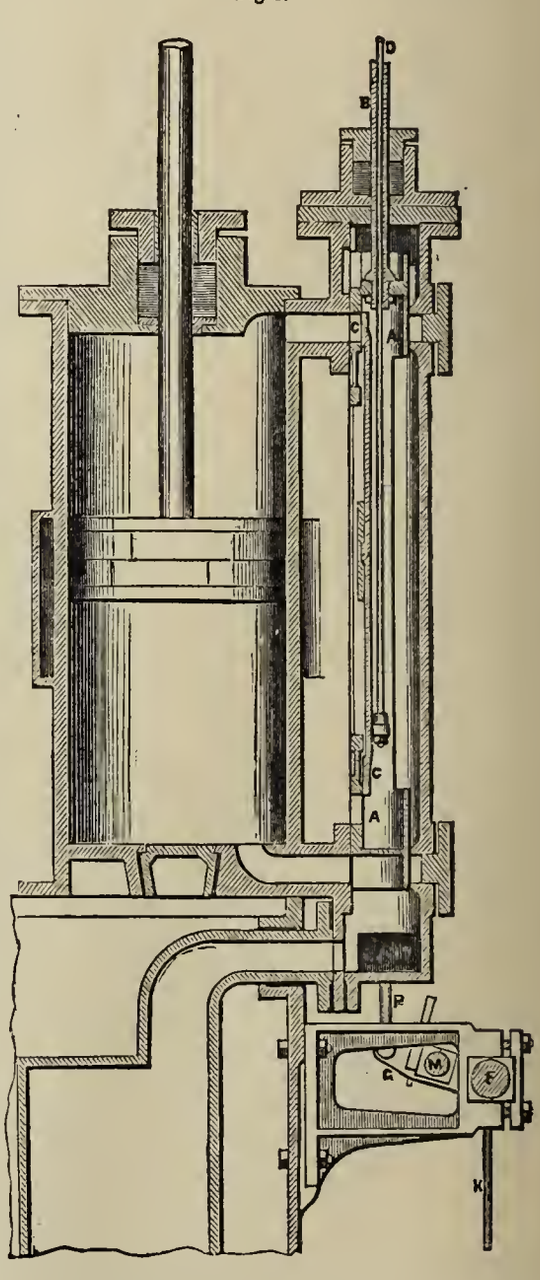
WHITELAW'S STEAM-ENGINE EXPANSION GEAR.

The happy idea of employing steam expansively was elucidated as far back as the year 1776, when Watt experimented in this way upon an engine at Soho, the shut-off being accomplished in the same way as in pumping-engines at the present day, namely, by adjustable tappets carried by the engine's plug-frame, and acting upon a set of conical valves. A wide space, however, intervenes, before we find the principle worked up into anything like a system, and the time of the practical introduction of self-regulating valves dates still later.

The earliest propounder of a good self-regulating system—that is, where the governor is put to its legitimate use in modifying the degree of expansion to the actual requirements of the engine—as far as we can make out, was Mr. James Whitelaw of Paisley, whose centrifugal pump we described and illustrated last month. As neither the ownership of the proposition, nor the actual date of its occurrence, are generally understood or acknowledged, we may here draw attention to the fact, that the arrangement to which we allude was brought forward in 1834. As the plan possesses several features of value,—and its present publication will afford the means of settling the point to the credit of Mr. Whitelaw,—we have engraved complete drawings of it, with full details.

Fig. 1 is a vertical section of the cylinder and valve-chest of a stationary engine, fitted with the expansion apparatus. Fig. 2 is a plan of the levers, rocking shafts, and eccentric connections of the valves. Fig. 3 is a diagram of the valve connections; and figs. 4 and 5 respectively represent a plan and end view of the cam adopted for working the cut-off valves. The large steam-slide, A A, is of the D construction. Two ribs, one on each side, connect its upper and lower portions, the whole being cast in one piece. It is worked by the hollow spindle, B. The cut-off valve, C C, works on the back of the flat face part of the large slide, and, for an obvious reason, is made in two pieces, coupled in the centre, as shown. This valve is worked by the solid rod, D, passing through the tubular one of the large slide, — a stuffing-box being formed on the top of the latter for the prevention of any steam escape between the two rods. The steam escapes from the upper end of the cylinder into the condenser, through two flat passages, cast one on each side of the valve casing. The inlet and outlet to one of these passages are represented in fig. 1.

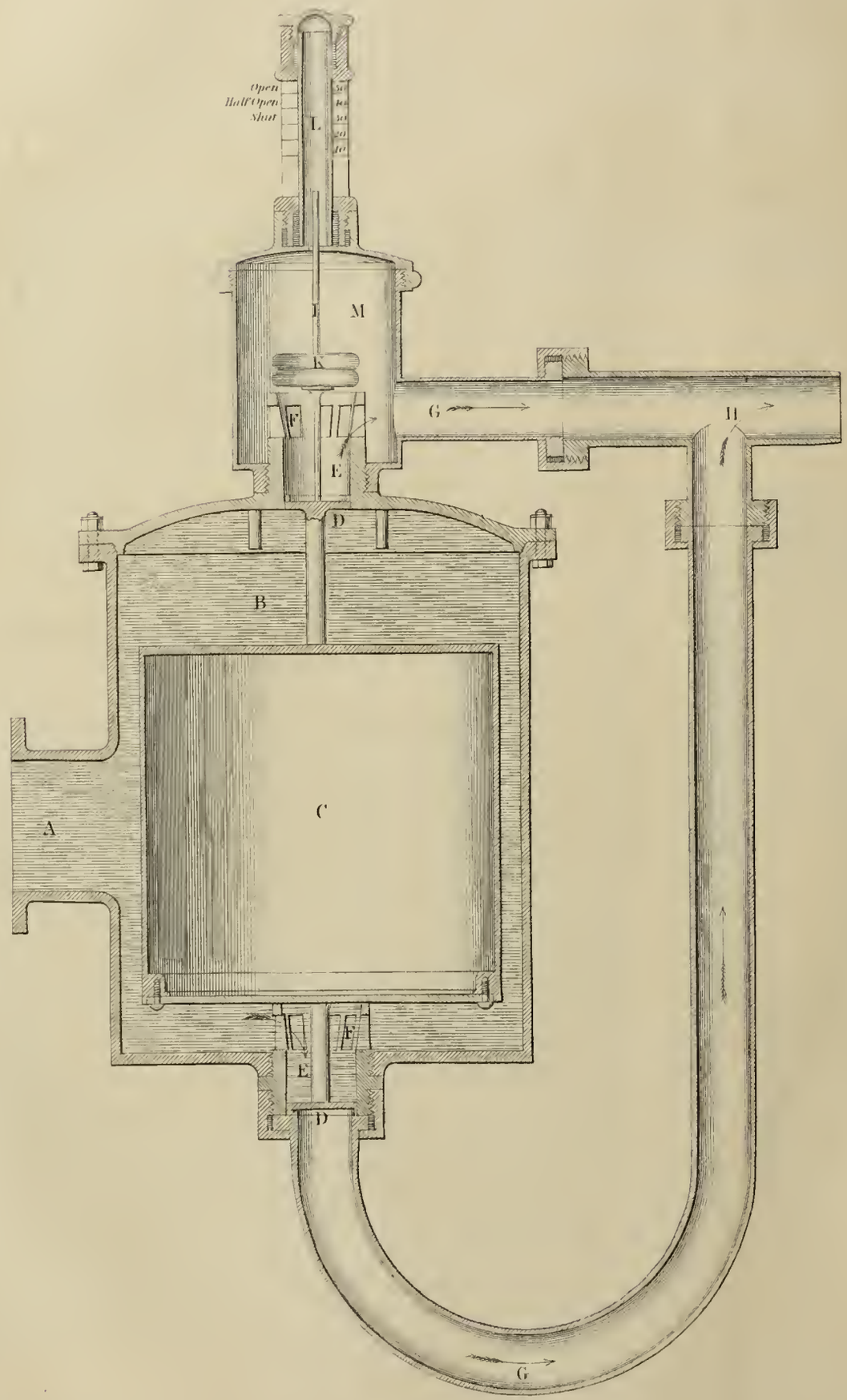
Fig. 1.



The D slide is worked by an eccentric, the gab end of the rod being

LUTHER'S SALINOMETER.

AND AUTOMATIC MARINE BLOW-OFF APPARATUS.



Scale of Inches

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W. Lorraine
Patent Office Augov.

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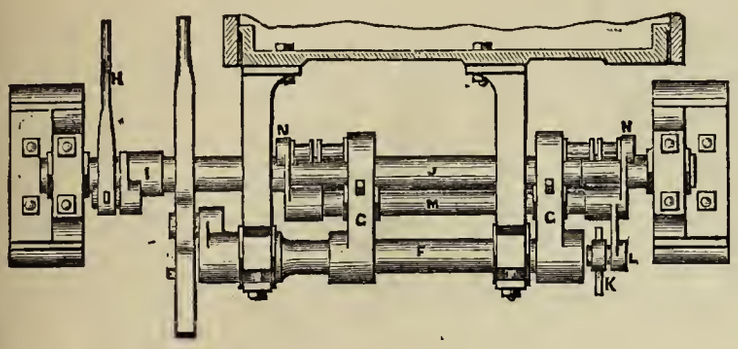
shown at E, in the plan, fig. 2, gearing with the pin of a lever on the end of the rocking-shaft, F, carrying the two additional levers, G G, which work the side-rods of the valve-spindle in the usual way.

Fig. 2.



The expansion, or cut-off slide, again, is worked by the cam, represented in figs. 4 and 5, which may be carried by the crank-shaft along with the eccentric. This cam gives motion to the rod, H, below, connected to the lever, I, on the rocking-shaft, J, which shaft carries a second lever, jointed to the rod, K. This rod conveys the movement to the lever, L, on an upper rocking-shaft, M, which works in bearings fastened in the levers, G G, of the rocking-shaft of the large slide. The pins of the two levers, N N, on the rocking-shaft, M, each carry a side-rod, and the upper ends of these rods work a cross-head fastened to the upper end of the rod, D, and thus the motion of the rocking-shaft, M, as communicated by the cut-off cam, is conveyed to the cut-off valve. As the shaft, M, works in bearings carried midway in the length of the levers, G G, and as the stud-pin on the end of the lever, L, is always close to the axial line of the rocking-shaft, F, the movement given by the eccentric to the connections of the large D slide, cannot materially affect the position of the cut-off valve on that slide; it is therefore obvious, that the position of this valve, in relation to the large slide, will always depend on that of the cam.

Fig. 3.

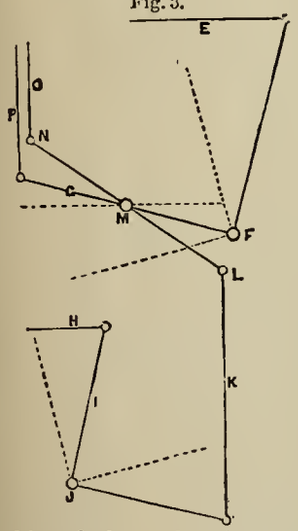
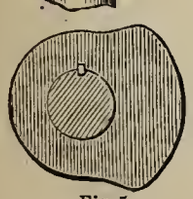


Fig. 4.

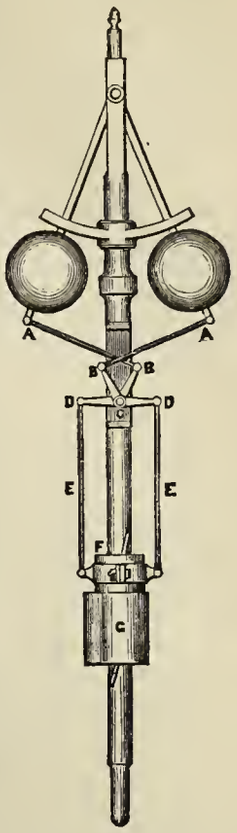
Fig. 5.



The diagram, fig. 3, will make this peculiar movement a little clearer; in it the various levers and rods are all marked, as in the detailed figures. The lever on the end of the rocking-shaft, F, is shown projecting *above* its shaft; whilst in fig. 2 it hangs downwards, the alteration being made for the sake of clearness. The rod, O, is one of the side-rods, working the cut-off valve cross-head; and here, as also in fig. 1, the rod, P, is one of the pair actuating the cross-head of the large slide. With the cam, figs. 4 and 5, set on the shaft with a fixed spiral feather, with freedom for traversing laterally, it is evident that the ordinary governor may be applied to work it, so as to furnish all the requirements of an accurate self-regulating cut-off. Thus, if the cam is shifted along the shaft in either direction, the action of the spiral feather will cause it to turn back or forward accordingly.

Fig. 6 shows how the cam may be judiciously fitted on the governor-spindle itself, rendering the self-acting regulating arrangement very simple. The ends of the pendulous arms project a little through the balls, for the purpose of being jointed to the crossed links, A A, the opposite ends of which are similarly jointed to the pair of bell-cranks at B B, which oscillate on a centre at C. This centre is contained in a slot or opening formed in the governor-spindle,—this part being shown in section, for the purpose of giving a clear view of the mechanism. The opposite arms of these bell-cranks, D D, are jointed to the two vertical rods, E E, passing downwards to a gland or collar, F, which fits loosely in a flat ring groove, formed in the upper end of the cam, G. This cam, as previously detailed, is carried upon a fixed spiral feather on the spindle; and of course, as the governor-balls expand or contract with the varying speed of the engine, the cam will be lowered or raised accordingly; and the spiral feather will, with this movement, set it back or forward, as the case may be.

Fig. 6.



If the governor-balls are heavy enough, the connections may be so arranged that a very slight movement of the balls will shift the cam to any required extent, with great delicacy of action.

This gearing possesses all the practical advantages which a good movement of the kind ought to embody. It is very light; there is never any objectionable steam-pressure upon the cut-off valve during any portion of its movement, and its close proximity to the cylinder is favourable to economy in steam.

Although the very contrivance now before us was fully explained at the early date which we have assigned to it, we have been given to understand, on tolerable good authority, that an engine-builder, in the neighbourhood of Manchester, has, even in late years, succeeded in obtaining £1 per horse power, in the shape of royalty, for all engines erected by him with the same arrangement. In reality, no patent for the plan is in existence.

MATHER'S SALINOMETER, AND AUTOMATIC MARINE "BLOW-OFF" APPARATUS.

The rapid accumulation of solid matter in marine boilers, is the source of some of the greatest inconveniences met with by the steam-boat engineer. The principle of evaporation turns every boiler into a chemical sieve; the pure fresh water passes off in the shape of steam, whilst the solid matter found in sea-water is, as it were, caught, and remains behind, until, by constant accumulation, the steam-forming contents present an appearance very different to the water as it comes fresh from the sea. Thus the flues, and other hot portions near the bottom, receive the saline deposit most rapidly; the evaporative power of the boiler is lessened by the interference of this effective non-conductor of heat, and, as the worst evil, the metal of the boiler is burnt.

The only remedies hitherto in use for the prevention of this difficulty are, the periodical discharging of the saturated water from the bottom of the boiler, technically termed "blowing-off;" and the "brine-pump," introduced by Messrs. Maudslay and Field, for the constant abstraction of small portions of the dense water, amounting in the aggregate to one-fourth of the amount of feed-water originally supplied. Previous to blowing off in the ordinary way, it is always necessary to fill up the boiler higher than the regular working level, and hence arise the evils of a wasteful expenditure of fuel, and a variation in the steam-pressure and feed, with irregularities in the working of the engines, and the boiling up and passing over of the water along with the steam. It is evident that, whatever may be the merits or demerits of these plans in other respects, they both require the vigilant attention of the engineer; and as he has no means of accurately ascertaining the state of matters in the boiler, his movements with regard to the dischargo of the brine must be often made at random. This defect in the management of steam machinery, appears to be completely remedied by Mr. David Mather, the engineer of the Dundee and London Steam Shipping Company, who has introduced an elegant little apparatus, which not only affords a constant accurate indication of the density of the water in the boiler, but is itself the means of discharging the dense stratum, without any assistance from the engineer.

The figure in our plate represents Mr. Mather's very ingenious apparatus in sectional elevation, one-fourth the real size. The whole apparatus is placed outside the boiler, a pipe from which communicates with the branch, A, on the brine-receiver, B, which is cast in brass, with a solid closed bottom, but open at the top, to receive a slightly convex lid, which is bolted upon it. In this receiver is contained the hollow salinometer float, C, which is also of cast brass, with a solid top, the bottom being filled in and made tight by a separate disc screwed on. In the centre of the top and bottom of the float are light vertical rods, the ends of which carry the disc piston-valves, D, D, fitted to work accurately in the upper and lower cylinders, E, E, like pistons. The upper cylinder is cast in a piece with the cover of the brine-receiver, into which it opens to receive the upper piston-valve of the float. The lower cylinder is screwed into the centre of the bottom of the receiver, on which there is a short collar formed to receive it. It projects for a short distance into the receiver, and forms a rest for the float, when the latter is in its lowest position, as drawn. Both cylinders have a series of ports, F, F, disposed in a ring near the upper ends of each; and it is by these ports that the brine escapes when the valves are open, passing along in the direction of the arrows, by the upper and lower copper branch pipes, G, G, to the main discharge pipe, H.

A small spindle, I, passes up from the upper valve, to carry the adjusting weights, K, as well as to act as the salinometer index, by projecting into a glass index tube, L, carried upon the top of the small chest, M, which is screwed on to, and covers, the upper cylinder.

According to our drawing, the water in the boiler is supposed to be below the limited standard of density; the receiver is in direct communication with the boiler, and is filled with a sample of its more dense contents; but the specific gravity of the fluid is too low to raise the float, which consequently rests upon the top of the lower cylinder, E, and the valves being below the level of the discharge ports, little or no escape takes place, only sufficient to allow the dense fluid to be carried into the receiver. As the evaporation goes on, and the density consequently increases, the float ascends correspondingly, but no discharge occurs, until, as a reference to the index will show, the top of the stem, I, reaches past the graduation 30°—marked "Shut." At this point, the lower edge of each piston-valve is coincident with the bottom of the series of ports; and the slightest further upward movement opens a way for the escape of the brine, as pointed out by the arrows, until it arrives at 40°—marked "Half-open;" and a continued increase of density carries it up to 50°, or "Full-open." Further ascent is prevented by the pins projecting downwards from the cover of the receiver, which pins form a stop for the float, when the stem stands at 50°.

When the density in the boiler lowers, the float, of course, gradually cuts off the escape of the fluid; and thus the apparatus constantly clears off the saturated water exactly in proportion to its accumulation.

The perfect balance of the pressure upon the two discharge valves in this contrivance, removes all doubt as to the delicate action of the float; and the arrangement for discharging the fluid by several apertures, provides against the difficulties connected with the chance of filling up one or two of them.

SHAW'S INDIA-RUBBER AIR-GUN.

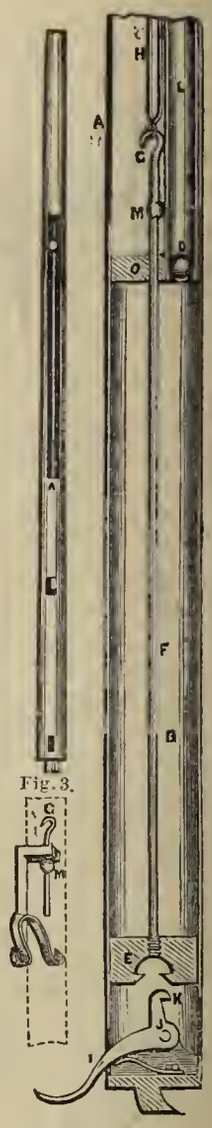
Our readers will, we presume, agree with us in thinking that the name of this invention presents an odd combination of terms; caoutchouc not being exactly the material of which we should choose to make air-guns. The gun, however, owes little in its constructive details to this substance, as it simply plays the part of a substitute for a portion of the mechanism of action in the ordinary air-gun.

The contrivance is the invention of Mr. John Shaw of Glossop, near Manchester, and the ingenuity exhibited in this peculiar combination of the elastic power of vulcanized india-rubber and air, reflects great credit upon him.

Our engravings represent, in fig. 1, a full view of the barrel of the piece detached from the stock, on a small scale; fig. 2 is a longitudinal section of the portion of the barrel containing the air-cylinder and piston; and fig. 3 is a sketch of the hook employed in extending the caoutchouc spring, answering to the loading action of the piece. The stock is of the usual shape, so that the entire gun differs in no external feature from a common percussion piece.

A longitudinal slot is formed at A, in the case or barrel portion of the gun, the part at B, behind which, is formed into an air-cylinder or pump, one extremity of which is formed by the breech, whilst the opposite one arises from the insertion of the top disc, C, perforated in the centre for the passage of the piston-rod, and at the top side, for the reception of the ball, D. At E, is a piston fitting accurately to the barrel, and screwed upon the rod, F; the opposite end of which is formed with a hook at G, upon which are hooked a set of 16 or 18 bands of vulcanized india-rubber, H, of a section of about $\frac{1}{8}$th inch square. The contrary ends of these bands are all similarly hooked upon a fixed bolder in the muzzle end of the case.

Fig.2. Fig.1.



The trigger is at I, at the breech end of the barrel. It turns upon a centre at J, and has a short catch, K, set to hold in the hollow at the back of the piston, when the latter is drawn down preparatory to the discharge. The power for this purpose is obtained by forcibly drawing down the piston to the breech, by means of the hook, fig. 3. If the barrel is rifled, the ball must be first driven down its barrel, L, to its contracted recess in the end, as represented in the sectional view. The rectangular end of the hook is then inserted into the slot, A, in the barrel, between the head, M, and the hooked end of the piston-rod, and the butt end of the piece being placed upon the upper part of the thigh of the sportsman, the spring is extended, and the piston being brought down to the breech, catches upon the projection, K, of the trigger, so as to be held until the latter releases it.

It will be seen that the portion of the barrel, beyond the head, C, of the air-cylinder, is not really the barrel of the piece, but is merely formed in continuation of the cylinder portion, to receive the spring, and the inner barrel, or traversing channel, L, of the ball.

With an unrifled barrel, 400 discharges may be made per minute, as the bullet in that case requires no ramming down, being drawn along its channel by the partial vacuum caused by drawing down the piston. The sectional view shows the piece in the act of discharge, the piston having just been released by the trigger. The re-action of the spring, H, causes the piston to rush to the head of its cylinder, and the rapid and powerful condensation of the air in the cylinder, thus occasioned, forcibly ejects the ball. It would at first appear, that the propelling power thus obtained would be comparatively powerless, from the evident fact, that the air must be brought up from the ordinary atmospheric pressure, to the full extent of condensation required for the sharp expulsion of the ball. The specimens of discharged balls supplied to us by Mr. Shaw, show, however, that the power generated in this way is really fully equal to the average of the common air-gun. Fired against an iron target at twenty yards, these balls are completely flattened out. No separate reservoir is required, neither is there any pump or delicately constructed air-valve; thus, whilst it possesses every advantage as to simplicity of construction and action, it is free from the chances of explosion of the reservoir of the ordinary air-gun, and all the discharges are of uniform strength.

Fig.3.

AMERICAN ENGINEERING.—LOCOMOTIVES.

[Continued from Page 243, Vol. II.]

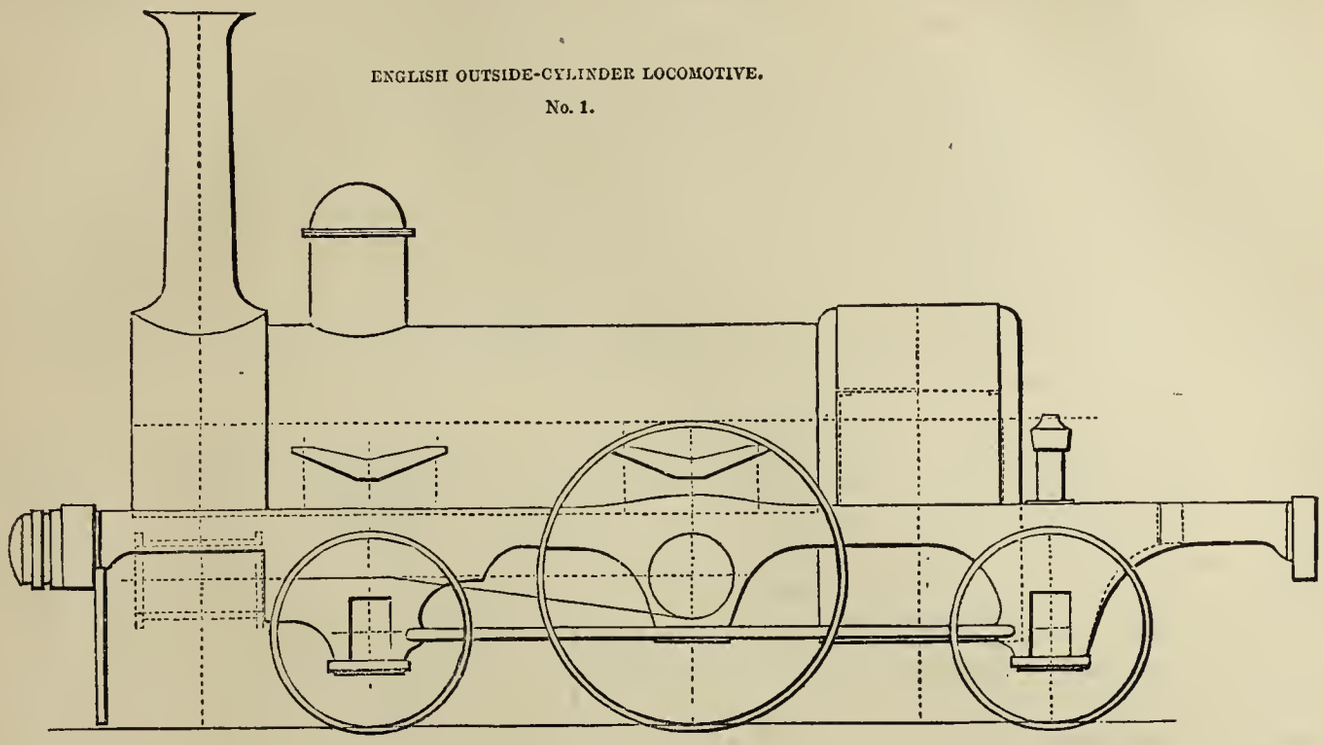
The American locomotive differs widely from the English engine, and both systems have their points of superiority: as far as design goes, I believe the American engine may claim the first place; in execution and proportioning of details, the English engine stands unrivalled. The previous pages devoted to the Frame, will show that I intend to compare the various systems; and by this comparison, and by applying the principles and theory of construction, to elucidate that which is good and commendable, and guard against what is bad.

The word "theory" has been often misapplied to investigations, apparently scientific; but, in practice, not only utterly useless, but which have even proved, when the test of actual working has been applied to them, erroneous, and opposed to facts. Hence the old and oft-repeated saying—"Many things are good in theory, but bad in practice,"—has

received a semblance of truth. But in all such cases we shall find the reasoner to be misled; that he comes to wrong conclusions from correct premises—that he—not science, is wrong. Many wild schemes have been thus pushed forward,—there is the perpetual motion, the inventors of which are blind to the absurdity of creating something everlasting out of decaying materials;—the multiplication of power by mechanical move-

ENGLISH OUTSIDE-CYLINDER LOCOMOTIVE.

No. 1.

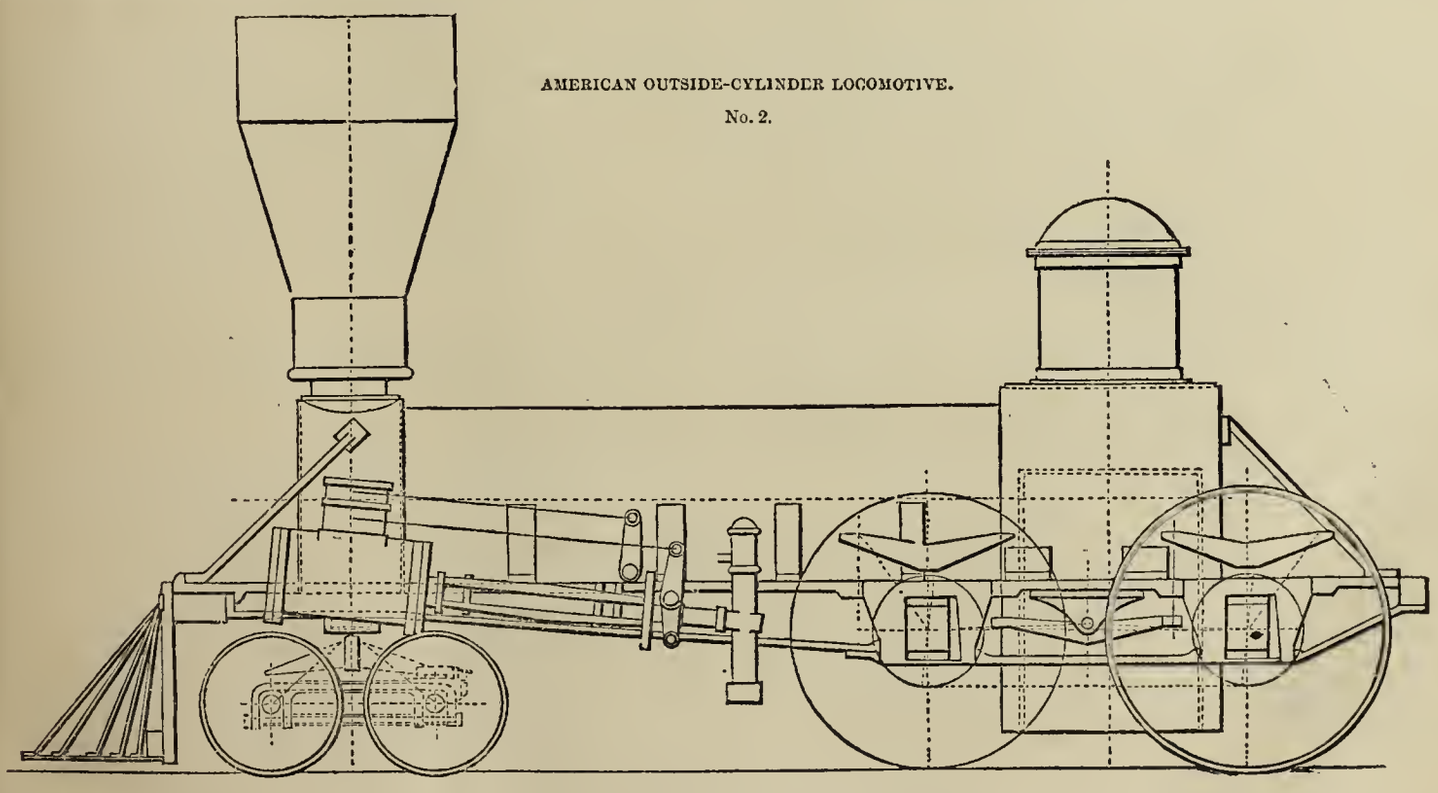


¼ in. = 1 foot.

ments, whereby a baby is made to do the work of a 100 horse-engine; the designers wholly forgetting the effect of friction and weight, and being profoundly ignorant of the fact, that power is gained at the loss of speed, and that the effect of power is the product of speed and power. There was the hydraulic railway, and the compressed air railway, in which, at certain points on the road, the boiler, or reservoir (being

AMERICAN OUTSIDE-CYLINDER LOCOMOTIVE.

No. 2.



¼ in. = 1 foot.

divided into air-tight partitions), was to be inflated with air at an immense pressure; the use of the partitions being, to prevent the too rapid diminution of pressure, and to keep always on hand some air of real high pressure. In the same proportion in which railroads have taken hold of public attention, have dreamy schemers tried to introduce impossible projects, and have caught hold of shadowy schemes, by which to attain all imaginable but impracticable ends. Such would-be inventors reason wrongly, because they do not admit into their calculations such

facts—and principles which are proved by facts, as bear upon their case, either because they are ignorant of them, or because they are too infatuated on the score of their own cleverness. In either case, they are not fitted to work out a practical design, and the name of theory applied to their calculation is a misnomer.

True theory cannot be wrong; and its application to manufactures or general practice can never lead to error. For what is theory? It is the generalization of the results of experience to simple expressions, which greatly facilitate the use of former experiences in new designs. Experiment has proved the pressure of the atmosphere to average 15 lbs. to the square inch. Experiment has shown this pressure to be exerted equally in all directions. These are first principles. Arithmetical calculation being brought to bear upon them, a theory is the result, by which, for instance, an engineer calculates the area of his safety-valve. Had he no such theory, or no such generalized expression for facts, the safety-valve in every case would be constructed by guesswork, and, to test its accuracy, he would have to create a vacuum above it, raise steam in the boiler, and load the valve by means of scales, then attach his levers and weigh them, till the same balance was produced. After a few such trials he would come to general results, by which he would act in future cases. That would then be his theory; but to make these experiments, much science is required. Scientific men have made them, and practical men make use of their deductions—of their theories. A body heavier than water, sinks in it; one lighter than water, floats. Fluids contained in vessels of unequal size, connected at the bottom by a narrow tube, balance each other. A small power exerted at the long end of a lever, overcomes a large resistance at the short end. These are called principles, or laws of nature, because in every case they hold good. Such principles, with many others, led to the construction of the hydrostatic press. Other principles were admitted into the calculation, new ones were observed, and the theory was raised, by which these presses are now made of such perfection and strength. Many a mechanic uses them, and makes them, and laughs at the idea that there is theory in their construction. The combination of principles forms a theory; theories classified into systems, form sciences. Sciences, which—though to the unlearned are without apparent connection—are founded upon the same elementary principles—form branches of philosophy, such as astronomy, optics, mechanics, meteorology,—all are branches of one great natural philosophy.

Every observant man has his own theory—he has derived it from his experiences through life. But if his theories are to be correct, they must be based upon correct observations, upon true—not fanciful or made-for-the-purpose—principles; and his mode of generalizing and thinking must be sound. He must have what is usually called a clear head. Two men observe that beams of various cross sections support various weights. They have to construct new ones for some purpose. They calculate the cross section according to former experience. One lays his beam on the flat side, and it breaks; the other lays it on edge, and it does not break. The calculations of both are based upon the same principles. The one, observing all facts, had formed a theory; the other had observed only half the facts, and therefore his deductions were only half a theory. Failing in practice is not a proof that one fact is worth a dozen theories, but is only a proof that the man's mode of reasoning was deficient and practically bad.

Some men have an intuitive perception of mechanical principles. Theories, which others have to acquire by study, seem to form a part of their mental organization. This we call talent. Talent is ever active—always designs. Such talent carefully cultivated, its possessors become the leading men, the main props of their profession; Watt, Smeaton, Brindley, Telford, the late G. Stephenson, I. K. Brunel, Rennie, W. Fairbairn, and R. Roberts, are such men.

Let not practical men, then, turn away from my remarks, when I say I shall apply the theory of construction to the building of locomotives. Where there is no opportunity for trying experiments, reasoning must supply their place, and, if based on sound principles, must lead to the same results. In giving an opinion on an engine, I am not guided by the builder's opinion—if so, I should be led to consider every engine perfect;—but I watch them on the road and in the repairing shop, and inquire among superintendents, drivers, and workmen. My views for rendering an outside-cylinder engine steady at high speeds, I stated in a former place; up to that time, the only engines of that class with which I was acquainted were English, or more or less copies from the English style. By observing them, and by reasoning, I came to certain conclusions, which, not having been tried, existed simply as theories. Arriving here, I found that experiments had been made, and such engines had been built, which were remarkably steady. My theory, therefore, was proved correct. The same results had been obtained in different countries, by different modes of handling the subject.

We find another peculiarity in all American engines, introduced as an experiment, found successful, and now universally applied. I believe it need only be known to be generally employed on all locomotives. Wherever stationary force-pumps are used, wherever a strong continuous stream of water is required, chiefly in fire-engines, which are nothing but locomotive—or loco-motive—force-pumps, this end is obtained by the use of an air-vessel. It is the simplest, most economical, and a never-failing plan; and, as far as I can ascertain, was first applied to locomotives here about five years ago, and by the same engineer, whose name has before been mentioned—Mr. M'Queen. The locomotive-pump consists of two pumps—one a sucking, the other a force-pump. The air-vessel is used either above the lower, or between the lower and the check-valve. Sometimes only one is used, sometimes two. It makes the pumps more efficient, and less liable to failure, in action. In the general employment of a separate cut-off, or expansion valve, the American engine also differs from that of English construction. So far as I was acquainted with the continental engines of Europe, a second valve was there always used, the link motion being employed merely for reversing. Of the superior advantages of this arrangement, I hope to be able to give a convincing proof.

DISTRIBUTION OF THE WEIGHT UPON THE FRAME.

After the consideration of the framing, and the principles according to which a solid one ought to be constructed, we must next investigate the manner in which the boiler, or body of the engine, should be connected with it, or braced from it.

The usual form of boiler-stay need not be described—it is in principle the same everywhere. In the English engine the fire-box is generally riveted, or bolted, at its extremities, to the frame. In American engines, an equalizing beam being used, the centre of which is equidistant from the wheel-centres, in the case of coupled drivers, it is plain, the attachments of the fire-box are best arranged, so that their bearing centres are also equidistant from the centre of the beam. This is attained in the manner shown in figures 1 and 2, page 220, vol. ii. of this Journal, and in the subjoined view of the Mohawk. In the manner of carrying the smoke-box, or fore-end of the boiler, there is a wide difference between the two systems. In English engines, with a round smoke-box—Stephenson's outside cylinders, the Jenny Lind, and others—a stay is carried to the frame, the same as for the barrel of the boiler in the engine here shown as No. I., the wings are carried straight down, and bolted directly to the frame.

In American engines, the smoke-box, with its heavy chimney, is a much greater weight, and therefore requires stiffer carriers. Great weight being placed at the top, and acting on the frame with great leverage, this part must be doubly strengthened. In most inside-cylinder engines, we find—as in figs. 2 and 3 of the frames—the cylinders to rest on, or sometimes underneath, the broad frame-bar by flanges. The two cylinders are connected together, either directly by flanges cast on, or by a separate casting bolted in between them, and carrying the gudgeon for the centre-pin. The cylinders, or this intermediate casting, are furnished with top flanges, curved to the radius of the smoke-box, to which the latter is firmly bolted, being thus supported on a broad base. This will be understood by reference to fig. 3, the breadth of base being from 15 to 18 inches.

How many boiler-stays are to be put on the barrel of the boiler?

Some engineers put in as few as possible, only one on the whole length. Some put in more, on the principle of a more equal distribution of the weight along the frame.

Experience has shown that a beam bears one-third more, if loaded along its whole length, than bearing only on the centre. Theory, or science, has proved why it must be so. Inversely, the weight remaining the same, it will be less strained; and therefore, as in the case of a locomotive, a greater proportion of its surplus strength is used to counteract lateral impulses. It may be objectionable to perforate the boiler with more holes than necessary; but it is still more objectionable to produce an unequal straining in the frame, and thus weaken it.

Using only one stay, it is of course placed somewhere near the middle of the barrel. Using more stays, we find them sometimes adjusted near the spring-bolts, as in fig. 2, page 220, sometimes on either side. The first plan is not a good one; for at the spring-bolt, all the vertical vibration not taken up by the spring is received by the frame, and thence imparted to the boiler. Place the stays between the springs, and the effect imparted to the body of the engine is less than the amount received at the spring-bolt, in the ratio of its distance from it; for the stability is affected only when the wheels on one side do not stand upon one horizontal plane. The frame between two wheel-centres then becomes a lever; at one spring-bolt the force acts, the other is the fulcrum; the effect received by the stay is in the proportion of the two lever lengths.

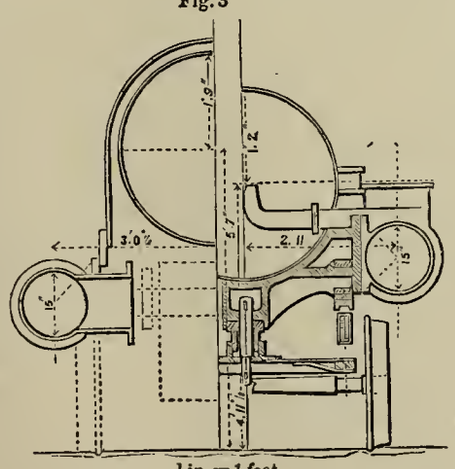
In many English inside-cylinder engines, as those by Messrs. Sharp

Brothers & Co., the transverse plate supporting the guide-bars is at the same time a carrier to the boiler. There cannot be a better way of bracing at the same time both the frame-plates and the boiler from them. However the braces or stays are placed, the principle laid down in page 101, vol. ii., should never be lost sight of—that is, so to arrange the fastenings as to admit of the expansion of the boiler, without producing a straining on the frame and working parts. I know that many practical men laugh at this idea as a mere "theory;" but where such very great accuracy and delicacy of adjustment and workmanship is required as in a locomotive, to make it durable, every cause of straining, be it great or small, should be avoided; and in this case it is easy to do so. Granted that the expansion upon a length of 12 feet is scarcely perceptible, it acts injuriously by constant unvaried repetition. Does not every engineer know, that however delicately and firmly he adjusts his slide in a cold state, as soon as it becomes hot its position is slightly altered; and in setting it he makes an allowance?

The boiler stays have another duty to perform. They are not carriers only. By their means the engineer distributes his weight on the wheels in the necessary proportions. The points of support for the engine are those where the frame is suspended from the springs. The longer the spring, therefore, the greater is the base of support; this is the theory, and practice proves a long spring to be more effectual in steadying the engine than a short one. Taking the *Pyracmon* as shown in Tredgold, we find the length of the spring on the fore-wheel to be 39 inches; the distance from the spring-bolt to the centre of cylinder, 5¾ inches; this gives the proportion of overhanging weight. It is still less, considering that the heaviest end of the cylinder is the back end, which throws the centre of gravity somewhat farther back than the centre of length. The greater size of driving-wheel in the *Iron Duke* allows the leading wheel to be brought farther forward; and the centre of gravity of the cylinder lies behind the point of support, that is, within the base. In the engine shown in No. 1.—the Tank engine—the length from the spring-bolt to the centre of cylinder is about 23 inches; that gives its ratio of overhanging weight. In the *Caledonian* outside-cylinder engine, also shown in Tredgold, the length is about 13 inches; in a sketch I made of Stephenson's outside-cylinder engine, 1845, I find it to be 20 inches; and allowing for the difference of the length of stroke —20 and 22 inches—it might, with the same arrangement and a 20-inch stroke, be reduced to 18 inches: all so much in favour of these engines over No. 1.

On referring again to the excellent engravings in Tredgold, we find altogether a better distribution of framing at the front of the Caledonian engine than in the Tank engine. As explained, the proportion of overhanging weight in the two, is as 13 to 23. Moreover, the centre of the axle, where the lateral impulse is imparted to the buffer plank, where, on the cylinder side, it is resisted, is in the Caledonian engine, 4 feet 2¾ in. Above all, the centre of the boiler of the first, with 6 foot drivers, is 3½ inches lower in the Tank engine than in the second, with 5½ feet, and 5 feet 1 inch drivers, while the boilers are the same size. Both engines running on the same line, under similar circumstances, the first is better adapted to resist oscillation. Moreover, the cylinder is carried by a double frame, 13 feet apart, and its centre line falls within this base; in the Tank engine, at a great distance from the centre, it is bolted by one narrow flange to the frame. At the centre of the cylinder the straining takes place.

Fig. 3

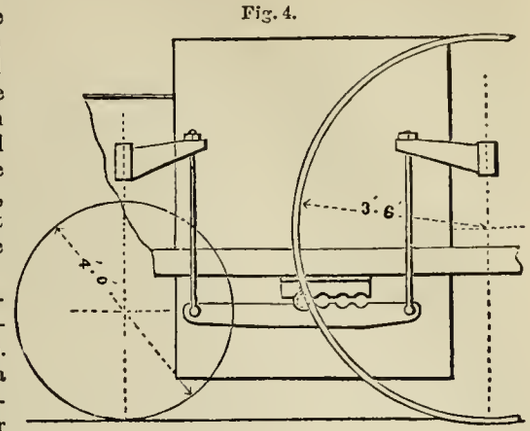


½ in. = 1 foot.

The Caledonian certainly has the disadvantage of a high cylinder, lying at considerable inclination; but it is so much better supported and steadied, that this disadvantage is in effect much reduced. Were the length of flues in both the same, then its driving axle might be placed farther back, the length of connecting-rod increased, and thus the angle of the stroke diminished, which would still more reduce the effect of the disadvantage.

Before leaving this subject, I refer to fig. 4. It shows part of an engine built here lately, on Crampton's plan, and, with the exception of truck and equalizing beam, is almost an exact copy. The driving-wheels are 7 feet diameter; the carriers 4 feet; the springs of both are connected by an equalizing beam, the centre of which can be shifted. Placed equidistant from the wheel centres, each wheel bears an equal weight; shifting the centre to one side, any amount of weight can be thrown on the drivers.

Fig. 4.



½ in. = 1 foot.

We may now return to the comparison of No. 1 and No. 2. The first is a sketch of an English outside-cylinder engine, the second a corresponding one of an American engine. Their dimensions have been stated at page 219. Fig. 3 gives half-cross sections of each, at the centre of the cylinders, showing the attachments at this part. It may seem bold to place an engine by one of the most renowned firms in England, having at its command the greatest talent and experience, in juxtaposition with one only rebuilt, too, at a railroad workshop, in a town the name of which is scarcely known to the majority of the people of England. But a glance at the cross sections will convince the most sceptical how the one must be unsteady, containing within its construction the very causes of oscillation—high boiler, insufficient fastening of cylinder, and great overhanging weight—whilst the other will move along the road as steady and smooth as possible.

I am favourable to outside connections, and in many circumstances prefer them—a predilection which many years' connection with railroads has not diminished. I think them both safe and economical—(see page 100, vol. ii.)—but they must be judiciously constructed. An engine like No. 1, when she has run a length of time, will be worn out much sooner than one with inside connections. This will be no proof that outside cylinders are to be deprecated. The fault lies in the builder, not in the system.

In fig. 3, the position of the driving-axle is shown by dotted lines. This will show how the position of boiler No. 2 is high enough for a 5½ feet wheel. We must not imagine, therefore, that the boiler is too high for a 5 feet wheel. Engines using wood as fuel require a greater depth of furnace below the barrel of the boiler, *i.e.* below the flues, than coke engines. The boiler in No. 1 is placed 7½ inches higher than need be. Why this inordinate height? It is not alone due to the tank. Even leaving the tank as it now stands, the boiler might have been lowered. But the same cubical content of the tank might have been preserved, had the boiler been lowered these 7 inches, and the top of the tank been curved to the shape of the boiler—thus gaining at the sides what was lost at the centre; or, there is room enough to admit of the eccentrics being shifted 1 or 1½ inches closer to the frame, and then widening the tank. In the distance of the centres of cylinders, an alteration might have been introduced. They are, in No. 1, 6 feet ½ inch apart; No. 2 shows them only 5 feet 10 inches apart, which still leaves ample clearance between the rod and the wheel. Thus, from 2¼ to 2¾ inches might have been gained on the great length of the steam-channels, which would materially have increased the firmness of the attachment of the cylinders.

I show dotted lines from the centres of both cylinders, to the centres of the bolts by which they are held to the frame. No. 1 is held by one row; No. 2 by two rows, one above and one below the centre. No. 1 rests against the frame by a flange just broad enough to admit of the bolt and its nut, for which three inches bearing surface is sufficient. No. 2 has a large bearing base of some 18 inches depth. The flange in No. 1 might have been increased to reach near the top of the frame, the leg of the smoke-box brought a few inches lower down, and then a double row of bolts, one of 5, the other of 4—a total number of about half those now used for this double purpose—would have produced a far firmer and more solid attachment. We must seek for a very firm support to the cylinder, for there is great strain acting at its centre.

Ceteris paribus,—the horizontal position of the cylinders in No. 1, is preferable to the inclined position in No. 2. American engineers know this, and admit it. But at what a sacrifice is this advantage gained? For the answer, I refer to the side elevations of the machines. No overhanging weight, the engine stands firm as a rock; with the use of the truck, all straining in curves is avoided. The truck does not admit of

large leading wheels. Such small wheels in the English engine, with only one leading axle, would, at great speeds, be unsafe. But while in the American engine the velocity of the axle is increased, only one-half the weight is placed upon it, so that the straining is still even less.

As to the performance of the two engines, I am unable to institute a comparison. They are built for different purposes: No. 1 for speed, No. 2 for power. They are about the same weight: No. 1 is stated to weigh 21 tons; No. 2 weighs about 22 tons. The accounts of performance of the Tank engine are too vague to found any comparison upon them.

The truck I have shown under No. 2, is not the one placed under her. It is one lately designed by the same engineer, and already placed under various engines. It is made of wrought-iron and boiler-plate, with cast-iron gudgeons for the centre-pin, and its construction will be readily understood from the drawing.

The iron framing in front of the engine is necessary on American lines; they being nowhere fenced in, and cattle frequently abounding in the adjoining fields. They are even called cattle-fenders, or cow-catchers. They are the more necessary, as the fire-box, with its ash-pan, reaches so much lower down than in coke engines. Stretching across the whole breadth of track, they clear it most effectually; far more so than the life-guards used in Europe. Certain it is, that on this cattle-fender coming in contact with a car, the demolition is more complete; but we must weigh the disadvantage in this case, which can only arise from negligence, and the want of proper signals, with the advantages in cases over which there is no control; which, from the want of fences, and the sharpness of curves, may in America be more frequent.

There is one feature in American locomotives which must be deprecated, and wherein the English engine has the advantage; that is, the too frequent use of cast-iron. In many cases, but chiefly where its power to resist compression comes into action, cast-iron is of greater value than wrought; but wherever it is subject to lateral strains or to torsion, it ought not to be used. I have seen, what to English engineers will seem scarcely credible, even rocking-shafts, with the levers cast on,—pieces of cast-iron of great size and weight, to resist the strains. The high price of the material, and the excessive wages, have led to a more frequent adoption of this brittle material, than otherwise would probably have been the case. While the general rate of travelling was slower than in England, the evil was not so great. But now, when the speed of from 40 to 60 miles an hour is being introduced, we shall gradually see cast-iron less used. Nearly all engines have cast-iron jaws for the axle-boxes. The engine No. 2 shows them. To avoid these, the builder designed that admirable wrought-iron one, shown in fig. 1, p. 220, which has since been placed on an engine of the same class, on the same road.

These various sketches of frames will show the almost universal use of adjusting keys or wedges for the axle-boxes. I not only think that this plan is better, than trusting entirely to accuracy of workmanship, (it may scarcely occur once in fifty cases, still I have known an engine out of a renowned workshop, in which the driving-axle was not square with the frame, and the extreme thinness of the box, only $\frac{5}{16}$ths of an inch, rendered planing off and packing impossible, thus causing great expense for the alteration); but it provides the means for taking up any play which in time may take place from wear.

Cast-iron wheels, even 6 foot drivers, are admirably made here. The details of proportions I shall give at a future time, when I propose to give an investigation into the relative merits of the "link," and American expansive motion, for which a series of experiments are now making; also details of construction of various parts, with illustrative drawings.

T. Passavant.

New York, March, 1850.

EXHIBITION OF INDUSTRY, 1851.

The arrangements of the central executive committee on this undertaking, are now so far advanced, that notices have been issued to the secretaries of all local committees, to use their best exertions in obtaining and forwarding information as to the number and nature of the contributions likely to emanate from their respective districts. The 1st of May, 1851, having been absolutely settled upon as the time of opening the exhibition, no time must be lost on the part of intending exhibitors, in coming to some determination in reference to the part they mean to play in this great friendly competition. The 10th of May next, is mentioned as the date on which the general result of the inquiries of the committees should be communicated to the Royal Commission, and although there are many practical difficulties in the way of procuring anything like an adequate notion of the supply of articles at so early a date, yet, as this time has been fixed, we must urge upon all who propose to lend their assistance, to give information on the subject, as far as they can at present decide.

It is certain that many manufacturers will not, for some time, even commence to make the articles which they may eventually contribute, and it is equally certain, that upon experiments or investigations yet to be made, will depend whether or not some inventors or experimentalists will contribute at all; therefore, whatever statements are made at this stage, they must be considered merely as indications of the state of public feeling in the matter. At a recent conference between the chief municipal authorities of the kingdom, and the Royal Commissioners, the following "*Proposed Notice for Local Committees to issue in their respective neighbourhoods*," was prepared:—

"All persons desirous of contributing articles for the exhibition of 1851, are requested to give notice of such intention, and to transmit a general description of the nature of each article, and the space which will be required for the exhibition of it.

"A register of the names, and the particulars thus sent, will be made.

"It will not be necessary, in the first instance, to exhibit to the local committee either specimens of the articles to be sent, or to give a minute specification.

"The first point to be ascertained is, the probable number of exhibitors, and the space that will be probably required for the articles they may send. The local committee will hereafter determine on the principle on which the selection of articles for transmission to London shall be made; giving to the contributors full public notice of that principle, and of the mode in which it is to be carried into execution.

"It is difficult to decide on this important matter, without having some general notion of the space which it is proposed by Her Majesty's Commissioners to allot to each particular district. It will be the earnest desire of the local committee to make those arrangements in respect to the principle and details of selection which shall be most consistent with strict justice to the contributors, and which shall, as far as possible, prevent any party from being prejudiced by the premature disclosure of any particulars connected with the preparation or manufacture of the articles which he may propose to exhibit.

"The local committee have reason to believe that, should they find any difficulty in determining on the principle of selection and the mode of carrying it into execution, they will be enabled to profit by the assistance and advice of gentlemen of high character and scientific attainments, deputed by Her Majesty's Commissioners, and capable of giving information with regard to the views of the Commission, and to the proceedings which may have been adopted, or may be in contemplation in other districts."

Printed copies of the "*Decisions of Her Majesty's Commissioners on points relating to the Exhibition*" have also been issued, and may be procured from the local secretaries. These "decisions" embody, under no fewer than 148 heads, the settled details of the undertaking—as the "general conditions—subscriptions—management of funds—functions of local committees—foreign arrangements—special instructions to colonial and foreign exhibitors—prizes and juries—classification and special instructions in sections." These particulars, with the "classified lists of objects which may be admitted to the exhibition," which are also issued free, have now put the public in possession of all information necessary to guide them in making their preparations for the coming contest.

In financial matters, the first official statement, containing the subscriptions from 51 towns, presents a total of about £40,000, the city of London standing for £23,000 odd. Future statements will be given fortnightly; and as the functions of the now widely distributed committees are developed, we may expect a rapid accession to the sum we have mentioned.

The number of architectural designs for the exhibition building, which have been sent in to the central committee, in answer to the published request for assistance in devising the most suitable kind of erection, is 229; of these, London has contributed 128; the English provinces, 50; Scotland, 6; Ireland, 3; anonymous, 7; and foreign countries, 34. From such a heterogeneous collection as this, the committee appointed for all matters relating to the building, may cull what they may deem the best of the good points, which may be found in the mass of propositions. The names of the eminent men which appear in this committee, are a guarantee for good management on this head.

Long ere this, our readers will have been made aware of the substitution of honorary for mere pecuniary prizes, for successful exhibitors. In this, we think, they have acted wisely.

Under the 112th section of the "decisions," we are glad to find the following clause:—"Lastly, the Commissioners, in announcing their intention of giving medal prizes, do not propose altogether to exclude pecuniary grants, either as prizes for successful competition, or as awards

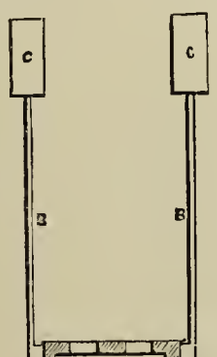
under special circumstances, accompanying, and in addition to the honorary distinction of the medal. There may be cases in which, on account of the condition of life of the successful competitor (as, for instance, in the case of workmen), the grant of a sum of money may be the most appropriate reward of superior excellence; and there may be other cases of a special and exceptional nature, in which, from a consideration of the expense incurred in the preparation or transmission of a particular article entitled to a prize, combined with a due regard to the condition and pecuniary circumstances of the party exhibiting, a special grant may with propriety be added to the honorary distinction. The Commissioners are not prepared, for the present at least, to establish any regulations on these heads. They consider it probable that a wide discretion must be left to the juries, to be hereafter appointed, in respect to the award of money prizes, or the grant of money in aid of honorary distinctions; it being understoodthat such discretion is to be exercised under the superintendence and control of the Commission."

We need only add to these notes—Let each man do his best.

NOTES OF AN EYE-WITNESS, ON THE BRITANNIA TUBULAR BRIDGE.

(Continued from page 14.)

Having explained the general features of the masonry, we may now give some detail of the more important arrangements as respects the disposition of the abutments and towers. The Carnarvon abutment being first approached by the down trains, we may begin with it. This abutment is situated on the high sloping ground on the Carnarvonshire shore. It consists of an abutment tower, 45 feet deep by 55 feet broad, at the level of the rails; and this is flanked by wing walls, 109 feet in length, as in the accompanying sketch of the plan. A, Is the horizontal section of the tower, with the two wing walls, B B, terminated by massive pedestals, c c, 28 feet 6 inches long by 13 feet wide. On each pedestal a colossal lion is couched, with his forefeet stretched out in front, but with his head erect. The face very happily expresses a vigilant guardianship; his dimensions are, from his toes to the root of his tail, rather more than 25 feet; and from the bed on which he rests, to the top of his head, 12 feet. There is a good deal of conventionalism in the style of execution of these sculptures; and this, perhaps, harmonises better with the bridge, as a work of mechanical construction, than if a strict representation of the forest king had been given. The foundation of the abutment tower is 42 feet below the bottom of the tube; and the walls are 9 feet thick at the foundation. At the level of the tube, two entrances are formed in the rail front of 13 feet wide each—one for each line of rails and tube. The inside of the tower forms a vestibule, 45 feet wide, and 22 feet deep, open at the top with an internal stone entrance, which opens immediately into the tube. The internal entrance, and inside of external entrances, have plain dressed stone labels along the lintels, and down the sides for about 7 feet; 5 feet above these lintels a plain belting course is carried round the vestibule, and 14 feet higher still, the wall finishes with a plain coping of two fascias. The ashlar is quarry-faced; this simplicity in the general arrangement, gives an air of great repose and dignity to the work, adding much to the general idea of its substantial massiveness.



The Carnarvon tower is the next in order of approach—it is situated on the beach as before-mentioned, upon a hard red shale, and the tide only reaches the foot of it at spring-tides. Its total height, from the foundation to the underside of tube, is 109 feet. Above the plinth it covers a space of 60 feet by 37 feet, but at tube level it is diminished to 55 feet by 32 feet. The face next to the water opening is built with two grooves of 15 feet 4 inches wide each, by 8 feet 6 inches deep at the plinth, and 6 feet deep at the bottom of the tube, to allow of the end of the tube being brought directly under the presses, so as to prevent any injurious strain upon either the masonry or the presses during the time of lifting. The lower portion of the outside pillar of each recess was left unbuilt until after their respective tubes had been floated to their places, to allow of the end of the tube being slewed round into the recess at the time of floating; after which, and before the lifting operations began, the pillar was completed, and securely underpinned by iron wedges, when it reached to the underside of the corbelling, which had been carried over temporarily.

At the level of the tube, the tower is formed by two outside walls, and one centre wall between the two lines of tube; the inside faces of which being at a distance of 7 inches only from the sides of the tube, have in each face three vertical recesses for the workmen, while forming the junctions across the tower between the land and water tubes. Above the tube the tower is a mere shell, carried to a height of 25 feet, with rough-faced ashlar externally, upon which are two dressed plinths of 6 feet total depth, from which rise the square pilasters of temple-finish for 9 feet in height, these again being surmounted by a plain architrave, with a bold projecting cornice, which completes the tower.

The front of the tower above the water tube, on the side next the water, has been left out, on account of leaving space for the hydrostatic lifting apparatus; but upon the completion of the lifting operation the whole will be closed in with masonry, as on the land-tube-face of the tower.

The total height of the tower from the foundation to the top is 186 feet.

The Britannia tower is built upon the Britannia rock, in the centre of the strait, and as its base is washed by the tide at all times, much delay occurred in preparing for, and setting the foundation stone, owing to the short time the men could work, the first stone being fixed below the level of low water of spring tides. The rock itself is a very hard intractable material to excavate—it is a schistose rock.

The base of the tower is carried up solid to 3 feet above high water of spring tides, at which level an offset or plinth of 12 inches is formed all round; the area left for the shaft of the tower being 60 feet by 50 feet 5 inches, which is diminished gradually upwards, until at the bottom of the tube the area is only 55 feet, by 45 feet 5 inches. At this level the tower is 122 feet 9 inches high from the foundation; the total height from the foundation to the top being 221 feet 9 inches.

This tower has grooves like those of the Carnarvon tower, for the guidance of the tube; but the Britannia tower having a water-way on each side, it necessarily requires two such grooves in each face. The inside of this tower is built hollow like the others.

The remaining portion of this tower, in its more general features, so nearly resembles the one already described, as not to need a more particular notice.

The Anglesea tower is similar in all its details and dimensions to the Carnarvon tower, the foundation only excepted. This is laid upon a rock bottom in the tideway, at nearly the same level as the Britannia tower. The base is built up solid to the top of the plinth course, as in the last-named tower; but the remainder of the shaft below the tube is an exact counterpart of the Carnarvonshire tower.

The height from the foundation to the underside of the tube is 124 feet, and the total height to the top of the temple is 201 feet.

The Anglesea abutment is built upon rock, and is the same in plan as the Carnarvon abutment, though much loftier, owing to the difference in level between the Anglesea and Carnarvonshire shores, as before-mentioned. The masonry in this abutment is of the same thickness at the bottom as in the towers—namely, 10 feet 6 inches, the wing walls and pedestals being the same thickness in proportion to their height as those on the Carnarvonshire shore.

At the level of the tube, the flooring for the ballasted roadway is formed with brick arches in the abutment tower, and between the wing walls and pedestals with a double line of vaulting, the bridge terminating in a heavy embankment.

Each of the pedestals supports a colossal lion couchant, as described in reference to the Carnarvon approach. The upper portion of this abutment tower is the same in detail and dimensions as the Carnarvon one.

The total height of the masonry in this abutment, from the foundation to top of tower, is 144 feet.

The total quantity of masonry, including brickwork in arches, and other details in the whole of the bridge, amounts to about 1,500,000 cubit feet.

As any description of the masonry of this bridge cannot be considered complete, without some allusion to the means used for bringing together, and finally fixing, so large an amount of material in so short a time, we may very briefly describe some of the more important arrangements for that purpose.

The whole of the materials being brought to the works by water conveyance, the first great object of the contractors, was the preparing of proper berths and wharves for the vessels to lie at while unloading, and cranes for discharging the materials brought. The wharves were built of whole timber, and from them tramways were laid for the wagons used in conveying the material on to the work-ground, to be prepared for the work. To facilitate operations in turning over the stone for the masons, and in stacking away the stock of ashlar on hand that was not immediately required for the work, the ground near the site of the bridge was parcelled off into breadths of from 30 to 40 feet wide, along each side

of which a row of upright balks with transom heads was fixed. A line of rails was laid upon the top of each line of heads for a traversing frame of trussed timber to run upon, and this frame again supports a powerful crab for lifting or turning over the blocks of stone, and also for carrying stone to any part of the ground which lay between the two parallel rows of upright balks; this arrangement may be better understood by those not practically conversant with such matters, by remembering that, whilst the traversing frame can be moved the whole length of the work-ground upon the parallel uprights, the crab can be run along the top of the trussed traversing frame on rails, laid for the purpose on the traversing frame, in a direction at right angles to the lines of the parallel transom heads. The whole of the frame is elevated about 15 feet above the ground, so as to allow of ample room below it for the purposes required; of staging such as this, about 1,200 lineal feet was erected for the working bank alone. At convenient places for the purpose, short tramways were laid for conveying the dressed stones to the situation for which they had been prepared; round the whole of the sites for the masonry of the bridge, whole timber scaffolding was erected; trussed traversing frames, with moveable crabs, as described for the work being used for setting the stone work. The scaffolding around all the towers and the abutments, was erected in heights of from 40 to 50 feet at once, and strongly tied with horizontal half-timber walings, the whole being securely fastened with iron dogs and screw-bolts, and stiffened by diagonal strutting, from the horizontal beams to the sides of the uprights. Upon the masonry reaching to the top of the first height of scaffolding, another "lift" was begun; but as the increased height made it impossible to steady the uprights from the ground, a method of scarfing, or what seamen term "fishing," was adopted, by which the whole of the staging —even when it had attained an elevation of 250 feet—was as secure as if built up in one length of balk only. The first operation in raising a second height of staging, was to bolt half-timber flitches upon two sides of each lower upright in such a manner, that, for one-half of their length, the flitches should stand above the top of the first stage, and form a clip for the lower half of the upright of the height of stage then being fixed; after which, the uprights were placed between the flitches, and the whole was firmly bolted together. The uprights being thus secured, the remaining portion of the stage was constructed in the same manner as the stage below; in this way was the scaffolding piled, stage upon stage, until a sufficiency of height was obtained for finishing the towers. At intervals, iron bolts were let into the masonry from the stage, to prevent the buckling outwards of the uprights, and to steady the staging in high winds, this being the only extraneous support which the stage received. As the whole of the stone, materials, &c. were hoisted by steam-power, a square framing of extra strength was carried up the side of each abutment and tower, better adapted to withstand the strain of lifting large masses at a greater speed than the ordinary staging. It is worth noting, that, in the whole of the staging, we have not observed a single scarf-joint, the heads and walings simply butting one against the other, and being held by dogs; this prevents the waste caused in London staging, by halving or scarfing the timbers, and is at the same time much stronger. The steam-engines employed on the Anglesea and Carnarvonshire shores were of 40 horse-power each, and when not engaged in hoisting were used for grinding mortar for the works; the one on the Carnarvon side being also adapted for sawing timber.

On the Britannia rock, an engine of 20 horse-power was employed in hoisting alone.

As the Britannia rock is covered at high water, a large timber platform was constructed at one end, for preparing and stacking the stone upon; a smith's shop and shelter-house for the workmen being built at the other end. The work-stage was provided with a traversing frame of the same character as those on the shore, for lifting and turning the stone.

With this general account of the masonry, and the preparations required for the same, we now turn our attention to the tube, with the attendant arrangements for constructing, floating, and raising it.

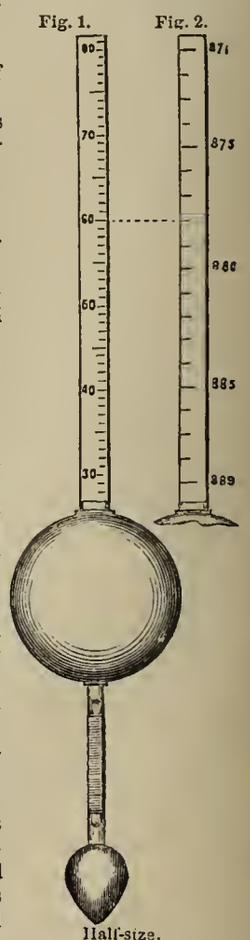
When the contracts for the tubes were first entered into, some difference of opinion existed as to the place where the tubes ought to be constructed, the general opinion being in favour of each contractor constructing his respective tube upon his own premises, the tubes being brought from thence, to the site of the works, in pieces of such size as should be found most convenient. But better counsels prevailed, and it was ultimately decided to construct them as near as possible to the place they must occupy when finally fixed. In consequence of this decision, surveys were made, and levels taken of the shores of the straits most favourable for this purpose; and operations were begun in the spring of 1847, on the Carnarvonshire side, by building suitable whole timber staging along the shore, sufficiently long and broad to contain the four large tubes for the water openings, with sufficient room at the sides for tramways, for conveying materials between the tubes and the workshops, and for putting together the sides—the platforms being built sufficiently high to keep the tubes clear of the tide at high water. Three large workshops were erected for the forges, and also machinery for the punching and shearing necessary in constructing the tubes.

A powerful crane, with suitable wharves, was also erected, with temporary houses to accommodate the large number of men who were necessary for prosecuting the work with vigour, as the houses round about were quite unequal to it. Thus, although the preparations for the masonry were very extensive, those necessary for making the tubes was not less so, either in magnitude or cost.

HUTCHISON'S THERMO-HYDROMETER, OR OIL-TEST.

History accords to Archimedes the merit of the discovery of the laws respecting the comparative specific gravities of fluids, and solid bodies immersed in them; and clothes its memorandum of the lucky thought in the well-known pretty story of the philosopher's bath and Hiero's golden crown. Upon the experiment of the immersion of this piece of kingly furniture, is founded the construction of the little instrument—which is now equally prized by the philosopher and the man of commerce—the hydrometer. The actual inventor of this instrument is unknown, but the earliest mention of it occurs in the fifth century, in some epistolary documents of Alexandria. In the sixth century, we find a Latin poem on the very unpoetical subject of weights and measures, containing a very clear description of the instrument, but by whom written there are no evidences to tell us. In the fifth section of the first part of Wernsdorf's *Poetæ Minores*, the curious observer may find a very complete account of the invention, with notes on its application. In Galen's time, the only mode of testing the density of saline solutions, was the very simple one pursued by the housewife of our own day—the immersion of an egg.

Throughout the fourteen centuries which have elapsed since the date of any existing evidence on the subject, many modifications have of course been suggested and introduced, but the arrangement of Twaddell in this country, and that by Baumé on the continent, have been almost universally adopted, whilst the system of graduated glass beads has been extensively used for many special commercial purposes. All these plans are so generally understood, that we may at once proceed to explain the improvement introduced by George Hutchison, Esq., of this city, and applied by him for the special testing of sperm oil.



In the ordinary hydrometer, no provision is made for what we may term, a self-correction for the temperature at the time being of the tested fluid, and although it is easy, theoretically speaking, to calculate the necessary corrective allowance, yet the want of a self-acting indicator which would give satisfactory results, without even the chance of error, has long been acknowledged. This is effectually accomplished in Mr. Hutchison's very elegant contrivance, which combines the temperature and specific gravity graduations on the single hydrometer stem, or, in other terms, it applies the thermal indications of the ordinary thermometer as the basis or standard of measurement of the specific gravity, in exact accordance with the actual temperature of the fluid to be tested; it therefore supplies an important want, in the shape of a trustworthy oil-test, for which so many purely mechanical schemes have been tried.

Sperm oil, for the testing of which the instrument illustrated in the two figures annexed is specially intended, being of less specific gravity than any other of the fixed oils, cannot be adulterated without becoming its own tell-tale, in the unavoidable increase in its specific gravity. Here, then, we have the fact, from the elaboration of which has arisen the ingenious oil-test now before us.

Fig. 1, as, indeed, we hardly need explain, is a complete elevation of the instrument, half-size, showing the thermal graduations carried on one side of the stem; and fig. 2 represents the graduated stem detached, as turned round to show the specific gravity graduations on the opposite side. The range of the instrument is restricted to the extent

of the known expansion of oil through 50° of temperature, as being sufficient for the purpose intended. The portion of the thermal scale to which it is adapted, is from 50° to 100°, for the reason that, whilst the first of these temperatures may be easily attained in the coldest weather, it is often necessary to heat samples of crude oil, rich in sperm, in order to secure that perfect fluidity which is essential to the free working of the instrument. On the side of the stem, fig. 2, are marked the actual specific gravities of samples in which the hydrometer sinks to the respective graduations—distilled water at 60° being 1000, or, with the decimal point after the first figure on the stem, the indication will express the number of avoirdupois pounds contained in an imperial gallon at the observed temperature. Thus, if the hydrometer stands at 875 at 60°, it tells us that 8·75 or 8¾ lbs. of the oil would fill an imperial gallon at 60°. This is the rate usually adopted in London for the conversion of a given weight of sperm oil into its equivalent measure, although it is a fact, that it is seldom so light. Good oil is generally about 878, and this is taken as the standard of the new instrument, as pointed out by the horizontal dotted line, drawn from the graduation 60° in fig. 1, in correspondence with 878 on the opposite side of the stem, as in fig. 2. To make this clear, we must remember that the graduations on the opposite side of the stem, fig. 2, correspond with the degrees on the thermometer, at which oil of the density 878 will sink the hydrometer to their several levels, being, in fact, a scale of the expansion of sperm oil for increasing temperatures, the effect of which is to obviate the necessity of calculating the correction for the observed specific gravity, which would otherwise be imperative for all temperatures but that of 60°.

The instrument, which is made entirely of brass, by Mr. Cohen of Buchanan Street, is contained in a neat mahogany case, 9 inches by 3½, made so as to carry the small testing thermometer alongside the hydrometer. In applying the instrument to test any sample of oil, the temperature is first ascertained by pouring a little of the oil over the projecting bulb of the thermometer, until the mercury sinks or rises to the exact temperature. The hydrometer is then placed in the oil, in which, if of the standard specific gravity, it will sink until the fluid level stands at the temperature graduation, agreeing with the observed temperature of the oil. If it sinks lower down or floats higher, the interval between the observed thermometer indication, and the degree pointed out on the hydrometer, by the surface line of the latter, is the measure of its actual superiority or inferiority. Increase of temperature produces increase of volume in all liquids, so that the volume corresponding to a given weight increases with the temperature; hence arises the necessity of fixing on a determinate point on the thermometric scale, to which to refer specific gravities for mutual comparison. In this country, water at 60° Fahr. is generally assumed as the unit, though in acts of parliament it is always 62°. In France, on the other hand, water at its maximum of density is sometimes taken as the unit—its temperature then being about 39° Fahr.; but more generally, water at 32° Fahr., or zero centigrade, is adopted as the standard. While a liquid remains constant in its qualities, and in all respects identical, it is not, perhaps, strictly correct to say that its specific gravity varies; nevertheless, the addition or abstraction of heat produces a change in the relation of weight to volume, precisely similar to a change in specific gravity, if the temperature had remained constant. It may be permitted, therefore, to use the phrase with this degree of latitude; that is, assuming distilled water at 60° as unity, to call the relation between weight and volume, expressed in terms of this unit, the specific gravity of a fluid at the temperature of the experiment; the fluid still remaining the same, to say its specific gravity varies with the temperature—that it is greater, for example, at 50° than at 60°.

Now, in respect of fixed oils, a given difference of specific gravity at any one temperature, remains sensibly constant at any other, the interval between two samples at 60° continuing the same when both are heated or cooled through the same interval of temperature. This is the principle on which this hydrometer is constructed. A standard of specific gravity for sperm oil is assumed, and a scale of its expansion with heat inscribed on the stem; but as the same scale is applicable to any other sample, with allowance of a constant difference, it is obvious that the difference between the temperature indications of the thermometer and hydrometer, becomes practically a measure of difference of specific gravity.

In fact, the specific gravity graduations, as in fig. 2, are valueless for ascertaining the oil's quality, as it is obvious that the temperature graduations are alone sufficient to give the required information. This may be summed up briefly thus. When the standard for any oil at 60°, or any other given temperature, is once determined, the hydrometer will invariably sink to the same point, the temperature graduations being thus pressed into service as actual specific gravity measurers.

In using the instrument as a test, if we consider the graduations of true specific gravity as pounds avoirdupois, they continually exhibit, at the surface of the oil, the number of pounds weight of it that are contained in 100 gallons at the same temperature. If the thermometer stands at 60°, and the hydrometer floats at 880°, we thus learn that 100 imperial gallons will, at the same temperature, weigh 880 lbs.

The exactitude with which this contrivance points out the commercial value of any oil, at once recommends it to the attention of the engineer, the merchant, or the manufacturer, or indeed to all who find it an important matter to ascertain the commercial value of oil, by a simple mechanical method.

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RECENT PATENTS.

PREPARATION OF COTTON AND OTHER YARNS.

James Aitken, *Glasgow*, *Manufacturer.—Enrolled March* 27, 1850.

This invention relates to a series of improvements in connection with the well-known dressing-machine, patented in 1839 by Messrs. Hornby and Kenworthy, and embodies—

1. The use of skeleton cylinders, or barrels, for immersing the yarn in the preparation or dressing troughs, instead of the ordinary grooved rollers employed for this purpose.

2. An anti-friction bearing for the journals of the squeezing rollers, through which the yarn is passed after immersion in the dressing mixture, wherein one bearing disc, or pulley, only is used in place of two, as in the common anti-friction bearing, the shaft being duly retained in its central position upon the pulley by a vertical slot in the side frames of the machine. The object of this modification is the obtainment of the ultimatum of simplicity in this class of hearings, and the power of putting in a larger pulley than would be practicable where two are used.

3. An arrangement of the steam-heating pipes in the preparation trough, for the prevention of the weakening and injury of the dressing mixture, by the use of non-perforated steam pipes. Two sets of pipes are provided—one perforated, the other not. To assist the first heating in commencing to work, steam is blown into both; but when the proper heat is acquired, the perforated pipes are closed to the access of steam, which is then only passed through the others, and the water resulting from condensation flows off without mingling with the preparation.

4. A provision for driving the rotatory brushes and agitator—if one is used—by special mechanism, instead of by the motion of the yarn in passing through the machine, which causes an objectionable drag upon the threads.

5. A mode of adjusting or varying the length of time during which the yarn is subjected to the action of the drying cylinders. At present this can only be accomplished crudely by a variation in the speed of the machine; but by placing a guide-roller in a slotted segmental frame, the curve of which is struck from the centre of the drying cylinder, the point at which the yarn leaves the cylinder may be nicely adjusted at pleasure, by simply moving the roller a little backward or forward, the yarn being made to turn over it.

6. The use of a shield, or cover, placed above the yarn at the point where the latter enters upon the drying cylinder, for the prevention of injury to the yarn by the fall of dirt upon the cylinder.

7. The use of an additional wheel in the gearing driving the marking apparatus, for setting off the lengths of warps, whereby the lengths may be more varied than is at present conveniently practicable, without an alteration of the index.

8. The use of sets of comb bars identical in pitch.

9. The employment of a revolving bar, or roller, instead of the breast beam, at the delivery end of the machine.

10. The moistening or steaming of the yarn after it has passed over the drying cylinders. The patentee finds it advantageous to the quality of the yarn to treat it in such a manner as to soften the prepared fibres, and fill up the pores in the material; and this he accomplishes by means of a steam pipe placed below, and in a line with the yarn beam, the upper surface of this pipe being perforated with small apertures for steam-jets to play upon the yarn during winding on. Although the steam-jet is preferred, yet water, or other fluid, may be used, if thought advisable.

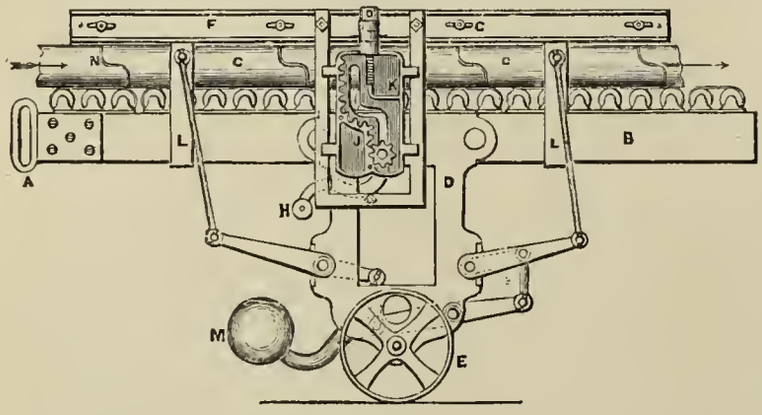
The claims are in accordance with these heads of improvement.

REGISTERED DESIGNS.

DRAIN-TILE CUTTING APPARATUS.

Registered for T. Dean, *Wishaw, and* R. Thorburn, *Broxburn.*

This is an ingenious apparatus to be attached to, and worked in conjunction with, the ordinary tile machines, the object being the accurate formation of the junctions of drain-tiles with overlaps, so that each tile, when laid down, will have a bearing upon its neighbour, and be prevented from getting out of the continuous line formed by the series. The engraving represents a full side elevation of the apparatus in working action, being joined to the tile machine by the slotted plates at A, on the side frames, B. These frames carry a set of bearing rollers, over the endless cloth of which the length of newly-formed tile, C C, is traversed, as indicated by the arrows, in its progress from the die. Two standards, D, carry the side frames, the lower ends of the standards being supported on the axle of a pair of running wheels, E, adapted for the conveyance of the apparatus from place to place. The top frame, F, carries the transverse cutting wires, G, four in number. It is worked by the winch handle, H, the shaft of which has a toothed pinion gearing with the teeth of an angular rack, J, formed upon a slightly projecting edge-face of a cast-



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iron piece, K, slotted through the middle in an angular shape to agree with the shape of the rack.

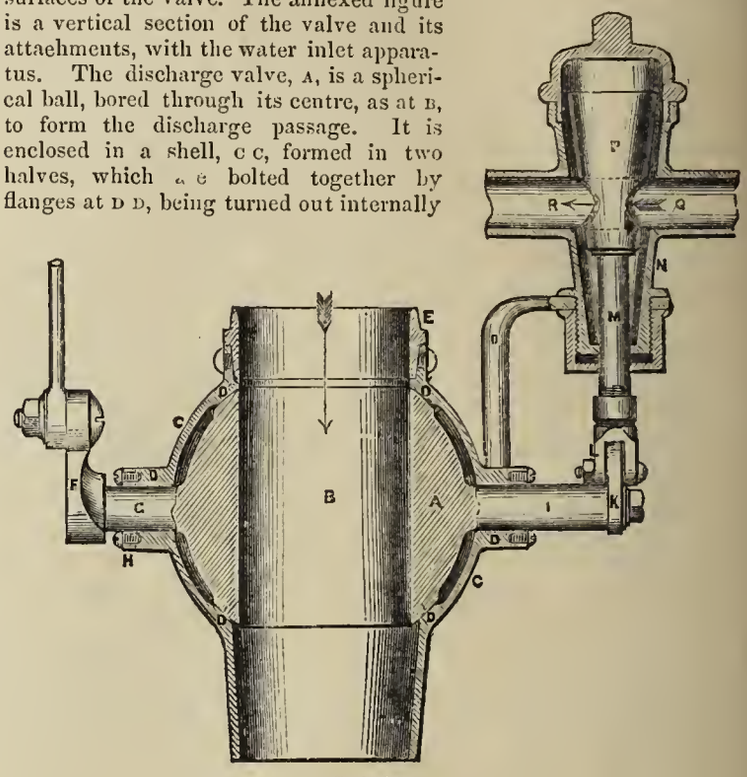
In cutting with this apparatus, the newly-formed length of tile is carried forward to the position represented in the figure, when it is cut into the required lengths by the descent of the wires, G, the frame of which is here shown in its highest position. When the handle, H, is turned, its pinion works the rack downwards, carrying with it the cutting frame, to which it is attached, a vertical guide being obtained by the guide-piece, L, sliding upon the outside of the side frame, whilst the weight of the moving apparatus is balanced by the weight, M, acting upon a set of levers and connecting-rods in connection with the frame. The revolution of the rack-pinion causes the rack-pieee, K, to traverse in the line of direction of the angular slot, through which the shaft of the pinion is passed as a guide. In this way the whole set of cutting wires are simultaneously traversed through the length of tile, severing it into lengths, by cuts, corresponding to the shape of the central angular part of the angular slot, as at N.

This arrangement possesses the merit of simplicity, whilst the form given to the ends of the tiles is a very good one as regards secure fitting.

SPHERICAL VALVES.

Registered for Mr. John Broadfoot, *Plumber, Glasgow.*

Our engraving of this design represents it as applied to a water-closet, for which purpose the arrangement is most peculiarly applicable. The advantages to be gained by its adoption are most prominent in connection with the fittings on board ship, where its employment will prevent the accidental opening of the discharge aperture by the motion of the ship, obtaining, at the same time, a superior tightness in the working surfaces of the valve. The annexed figure is a vertical section of the valve and its attachments, with the water inlet apparatus. The discharge valve, A, is a spherical ball, bored through its centre, as at B, to form the discharge passage. It is enclosed in a shell, C C, formed in two halves, which are bolted together by flanges at D D, being turned out internally



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to fit accurately to the ball surface—bearing at the parts D′ D′. The soil pan is placed upon a ring flange at E, in the usual manner, the valve, A, when turned partially round, so as to oppose the ends of its bore, B, to the solid surface of the shell, forming the bottom of it. The valve, A, is worked by the crank-arm, F, fast on the valve-spindle, G, which passes through a ground collar formed in the junction of the shell at H. On the opposite side of the ball is a second spindle, I, in a line with G. This spindle carries a short slotted lever, K, connected, by a pin, with the double eye, L, on the end of the vertical inlet valve-spindle, M. The shell, N, of this valve is carried on the end of a bent bracket, O, bolted to the flange of the discharge valve-shell. The shell of the inlet valve is bored or ground out conically, to receive the tapered or conical valve, P, on the top of the spindle, M. Water is supplied to this valve by the inlet branch, Q, passing out, when the valve is open, as represented by the arrows, by the opposite branch, R, leading to the pan. By this arrangement the partial revolution of the discharge valve, A, opens or closes the inlet valve at the same time, so that, when the discharge valve is open, the inlet valve is also open, to admit water to the pan. Owing to the spherical contour of the discharge valve, it can never be opened by any movement of the vessel. The full opening is easily effected when required, and a very clear passage is afforded for discharge.

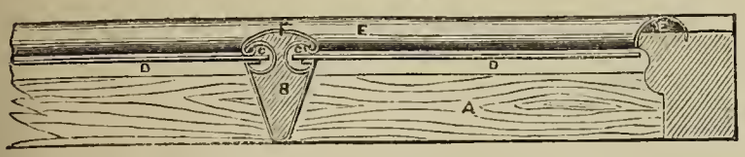
It is obvious that this spherical valve is applicable for a great many purposes, as it may be made very light, whilst it affords a full, clear water-way.

METALLIC SELF-VENTILATING LIGHT FOR CONSERVATORIES.

Registered for Mr. T. Nixon, *Kettering.*

The evils consequent upon the rapid decay of the frames of garden lights, are known and severely felt by every horticulturist; but we have, as yet, had no efficient remedy for them. We have, therefore, pleasure in drawing attention to Mr. Nixon's plan of "Metallic self-ventilating garden and sky-light," which promises something for the gardener's comfort. It is glazed without the assistance of putty, which is objectionable for many reasons, and, being self-ventilating, provision is made in it for the desideratum of a free circulation of air. The accompanying figure represents a longitudinal section of a portion of a sky-light or garden sash-frame, constructed according to Mr. Nixon's plans. A, Is the wooden framing, and B is one of the sash-bars, cased with metal. The

ventilating gutters or channels are formed at e c, in the metal casings, with the double object of securing the glass, D D, and acting as recep-



tacles for holding and conveying away moisture from the glass surface. A connecting channel, E, also of metal, extends all round the frame, and each sash-bar is covered with a sliding metallic cap, F, beneath which, and into the channels, C, the glass frames project.

The arrangement provides a very efficient protection for the wood of the frames, as all the exposed parts of the bars are covered with a metallic shield, and the moisture and vaporous exhalations are rapidly carried off by the channels formed as represented.

SPIRAL SPRING COMPASSES.

Registered for Messrs. Bentley, *Margate.*

All draughtsmen have felt the annoyance continually arising from the inequality of action of the joints of their compasses. After some little usage, these parts invariably imbibe the bad habit of an alternate tightness and looseness, so that when the screw is adjusted to tighten the joint for one part of its movement, the objectionable slackness is only removed at the expense of an equally provoking stiffness in another part. Messrs. Bentley's "spiral spring compass" aims at the remedy of this evil, by the adaptation of a small coiled spring to the joint, in such a manner as to equalize the pressure of the frictional surfaces throughout the entire movement. Our sketch, which represents a side view of the end of the centre joint of the compasses, explains the mode of application of the spring. The centre joint, A, which is sectioned to show the spring, has a recess bored out of one side of it, just large enough to receive the short coiled spring, B. When this centre joint is inserted between the two eyes forming the outer joints, the spring reacts from the bottom of its box against one of the eyes or cheeks of the outside joint, thus keeping up a regular smooth working pressure on the joint surface.

Externally, this little modification in no way affects the appearance of the instrument, as the spring, being entirely embedded in its recess, is not seen. At a mere trifle in the increase of the cost, an important objection is here remedied by very simple means.

REVIEWS OF NEW BOOKS.

Tredgold on the Steam-Engine. Vol. I. New Edition. John Weale. London, 1850.

Otherwise, "The Principle, and Practice, and Explanation of the Machinery of Locomotive Engines." However fashionable it may be for publishers to turn editors of their own publications, it is nevertheless consistent with reason, and proved in practice, that such a combination of functions in one person is not likely to be well done. Division of labour tends to the perfection of the products of manufacture; and in the case of Mr. Weale, with his new edition of Tredgold particularly, where there is no natural connection between the responsible supervision of a varied collection of material, and the business of superintending the execution of plates and letter-press, we require, besides the merely economical consideration of dispensing with separate editorial management, to know on what other ground the ambitious publisher could have assumed the onerous task of editing an edition of an esteemed national work on the steam-engine. A Dictionary of Terms, we believe, has been written by Mr. Weale, and, without even pretensions to being considered a work of research, it is imperfect even as a compilation,—it is fat in the wrong place,—it swarms with definitions of terms in architecture, about which everybody knows something; and it is merely sprinkled with definitions of engineering terms, about which few people know anything. It is plain that Mr. Weale is quite deficient in that sort of learning, which is not to be had from books,—which, at least, has not yet been divulged in print; he is, in short, not a practical man. In matters of useful art, the absence of the practical element,—that, in fact, which constitutes knowledge in the useful arts,—must be considered a vital defect; and, consequently, we find all Mr. Weale's self-edited works overrun with compliments to the "gentlemen who have liberally contributed," &c. &c. While, therefore, he is so absolutely dependent upon the contributions of others, for all that constitutes "information for practical purposes," there is neither good taste nor good sense in the assumption of an editorial position.

And this brings us to the volume before us. With his felicitous system of "papers," the editor has contrived to compound a heterogeneous mess for his readers. He well knows that the literature of locomotives is at a premium, otherwise this medley must have dropped dead from the press. First of all comes a "paper" of "Rules and Regulations for the Practical Management of a Locomotive Engine," by Mr. John Sewell, L.E. (Locomotive Engineer?) Editorial Blunder, No. 1. In place of informing us how an engine should be trimmed—fed with fuel and water, so as to take the most of the work out of the coke—how to work the expansion gear—how to keep down the steam, so as to prevent loss at the safety-valves—how to regulate the application of the brake on inclines and at stations—how to maintain a locomotive in the highest state of order—in short, how to make an accomplished engine-driver; in place of attending to these niceties, which must be comprehended in the idea of practical management, Mr. Sewell, L.E., tells us about the red flag and the white one, the high signal and the low one, interpolating pictures of policemen like old soldiers, holding their *arms* in various fatiguing positions, with other instructive matter of the same kind. Now, these matters, besides being irrelevant to the subject proposed to be handled, are really not of the slightest importance to engineers at large. The subject of railway regulations has already been amply discussed before parliamentary committees, and the only general conclusion arrived at has been, that one common code of management was inapplicable to railways. A partial system, therefore, of rules, applicable to one specific line of railway—in this case, the Great Western Railway—is of little value for other lines. But the editor did not know this; how could he? Appended to this paper of Rules and Regulations, we have a diagram of resistance per ton of the "Great Britain" locomotive engine; also, engravings of the "Iron Duke," the "Liverpool," and the "Pyracmon." We are not able to state the intimate connection betwixt the topic and the illustrations; neither does the locomotive engineer condescend to inform us.

Next in the table of contents, comes the "Second paper—Description of Mr. Samuel's Express Carriage Engine," an illustration of the folly of publishing expensive engravings of first thoughts. Hardly had the engravings issued from the press, when the carriage-engine was introduced, as an expansion of the other, and yet here the original is stereotyped as part of a national work. Mr. Samuel himself, we are persuaded, would much rather now decline the favour of such rude publicity.

"Third paper—Mr. Armstrong on the Dimensions of the Locomotive Engine Boiler," a very good and fitting subject. Mr. Armstrong has, however, occupied so much space with the general question of boilers, and the old story of the experimental kettle, that he has left himself only a couple of pages to discuss the peculiarities of the locomotive boiler, winding up with a formula, the application of which is exemplified in the case of one of Stephenson's primitive engines.

"Fourth paper—Mr. H. B. Barlow's Description of Messrs. Sharpe, Brothers, & Co.'s Outside Cylinder Tank-Engine," a well-written description, to which is appended an application of Pambour's formula to the performance of the engine in question.

"Fifth paper—Mr. Woods on the Consumption of Fuel, and the Evaporation of Water," &c.; an old "paper" brushed up to look like new. It contains valuable historical information on the performance of the early locomotives on the Liverpool and Manchester Railway, with plates, of course, showing how the valve moves in connection with the movement of the piston. All this is very fine; but, being elementary, Mr. Woods' paper ought to have preceded all the other papers. Where nothing like order prevails, however, it is really, after all, a matter of indifference which place in the order of papers it occupies. It looks just as well as if it were in the right place.

But there is little of any novelty to be found in this reproduction of Mr. Woods' paper. It is prefaced, it is true, with some disquisitions on the heating powers of the elements of fuel, derived from recent chemical researches, and upon the mechanical equivalent of heat; but that which Mr. Weale has distributed over nine quarto pages might have been expressed briefly by a few sentences, as regards all that affects the constitution of the locomotive. There is a style of vague generalization in the paper, as if the intentions of the writer were to propound the general principles of the application of heat in steam, and to combine with his exposition the bearing of the subject upon the locomotive. This vicious tendency to recapitulate and fall back upon general principles, *ad nauseam*, already referred to as characterising Mr. Armstrong's paper, and

discoverable even in Barlow's matter-of-fact description of Sharpe's engine, —the apparent disposition of all the "gentlemen" to dabble in scientific principles, having little really to do with the matter. These sins of commission, common to all the contributors, while they indicate the book-making policy of the editor, go very far to damage the utility of the work. Nothing tangible is left for the mind to seize upon, and to make its own. One is tantalized with remote allusions to Pambour's extensive formulas, and is informed that it is gratifying to find this formula continues to yield true results as applied to modern locomotives, &c. Bless his memory, yet fresh, the work of Pambour on the locomotive engine might have been reprinted in the new edition of Tredgold, and would certainly have afforded much more solid satisfaction, ancient though it be, than the paraphrasing effusions of indiscriminating authors. It is true, that since the time of Pambour's experiments on the locomotives of the Liverpool and Manchester Railway, some new and previously undiscovered principles have been developed, demanding a renewed series of experiments and observations to form a commensurate basis for a modern theory of locomotives, suitable to the practice of our own day. But infinitely rather let us have matters of fact, cautiously generalised, than the jejune lucubrations of milk-and-water writers.

To return to our muttons. Mr. Woods *has* favoured us with something tangible on the subject of expansive working:—

"The contrivance of some easy method of varying the power of an engine whilst in motion is still a desideratum.

"In one way, indeed, this is already in many instances done, by cutting off the steam at different points of the stroke, and working expansively; but, considering the comparatively low average pressure which the steam assumes in the cylinder at high speeds, and that it cannot be allowed to expand below the pressure of the atmosphere; also, that the last atmosphere remaining in the cylinder has not taken any part in the 'effective' duty of the engine, but is, so to speak, thrown away, whether the engine is worked expansively or not; it seems very doubtful in theory, and the results of practice would seem to confirm this view, whether any real advantage is gained by the so-called expansive working."

We are aware that Mr. Woods is not alone in his ideas of working steam expansively, and that other engineers of eminence are prepared to deny the peculiar virtue of expansive working. The results of practice, not to mention the very clear demonstrations derivable from a *prima facia* view of the question "in theory," have, however, very certainly proved the economy of high degrees of expansion. We may refer to an elaborate series of experiments made several years ago, on Mr. Woods' own line, the Liverpool and Manchester Railway, and reported in the first volume of the *Artisan*, to test the value of Gray's expansion gear on one of the engines, which was then being introduced. The comparative results showed satisfactorily the economy of expansive working of steam. But there is no necessity to appeal to experiment of such ancient date. The evidence of diagrams taken from the cylinders of modern locomotives, provided with considerable lap on the valves, and means of varying the expansion, proves the point beyond controversy. In one case it was ascertained by indicator diagrams, taking from a locomotive ascending a uniform incline at a uniform speed, with a given load, cylinder 15″ × 20″, wheel 6 feet, that, when the steam was cut off at 12 inches of the stroke, and worked expansively during the succeeding 6 inches, the work done was equal to that accomplished by cutting off at 15 inches, and expanding through 3½ inches, while the relative weights of steam expended was as 5 in the former case, to 6 in the latter case; that is, by working less expansively, one-fifth more steam was expended in the cylinder to do the same work. We do not, to be sure, found an argument in favour of expansive working, exclusively on such special comparisons as the foregoing. We are content to take average results, and it has frequently been proved on the same line of railway, that the same class of engine in the hands of drivers who adopt different modes of working, consumes varying quantities of steam, and fuel to correspond; quantities varying, in some ratio, inversely with the degrees of expansion practised.

We have purposely, in this place, avoided the general theory of expansive working, as it has often been amply discussed, and the benefits proved by numerous careful observations. Every one has heard of the Cornwall engines,—engines, the economical results of which were at one time so incredible, as to induce Mr. Wicksteed to transfer one of them bodily to London, and set it a-working, to prove that the reports were correct. The economy was due exclusively to expansive working, so far as the work of the steam in the cylinder is concerned; and there was no occasion to introduce the percussion dogma of Mr. Parkes, propounded for the purpose of explaining the almost impossible advantages of the system of working adopted. We are, then, quite unprepared for Mr. Woods' conclusion; and, it is hoped, we have shown that his views require some serious modification.

The sixth and following papers comprise descriptions of engines made by Stephenson, Tayleur, Bury & Co., Hawthorns, and Crampton. The selection and treatment of the topics of these papers, indicate the same intelligent editorship which superintended the getting up of the previous papers. For example, Stephenson's engine is selected, from his practice of ten or twelve years ago. Crampton's is selected, not that it was the most useful, but because it was the most monstrous; and although pompously announced as the most powerful engine upon any guage, it has never proved itself so. "Heating surface" is a cant synonyme for power: this is true only in a restricted sense; and there is much of professional ignorance in the man who can say that an engine is the most powerful, simply because it possesses the greatest amount of heating surface. It was shown by Mr. Ramsbottom, lately, that the proportions of locomotives had varied very much within the last ten years; and that considerations involving proportions and arrangement, as well as mere superficial extent of surface, influenced to a great extent the working power of a locomotive. For Mr. Crampton then to talk, as if heating surface and power were absolutely convertible terms, is to throw dust in the eyes of a discerning public, and in the face of a discriminating editor.

Mr. Weale's "paper" system is the ruin of his publications. He is victimized by all his "gentlemen," not, to be sure, intentionally, but necessarily, because each man holds his own peculiar views, and each man is allowed to develop his own prejudices; and that book which ought to have been the authority on locomotives for the time being—a second Pambour, in fact—becomes nothing more than a series of advertisements to suit the views of the advertisers. We are thus severe in our censure, for Mr. Weale obviously possesses all the material elements for producing a fine book. The plates are, most of them, faultless, and really deserve to be better represented in the letterpress; they are also valuable, because they represent the elaborations of long and cautious practice. But that specious, superficial stuff which so disfigures the text, and which ought to have been subjected to the editorship of a competent authority, spiced, though it be, with the complacent assurance of the editor, will ever prevent the first volume of "Tredgold," so called, from assuming the position of an authoritative publication.

Supply of Pure Spring Water to the Metropolis: Report to the Directors of the Watford Spring Water Company. By S. C. Homersham, C.E. Pp. 58. London, 1850.

On the Supply of Water to be obtained from the North Kent District: Report to the Directors of the South Eastern Railway. By P. W. Barlow. Pp. 8. London, 1850.

There are just now in existence no fewer than five projects for supplying London with water, and amongst so many opposing plans, it is no wonder that decision should be delayed, whilst the inhabitants are yet condemned to muddy and unwholesome water. The several schemes are—the Henley, the Mapledurham, the Watford, the Wandle, and the Kingston. A valuable report on the first two of these plans has been issued by Mr. Walker, the engineer, and Mr. S. W. Leach, the engineer to the City Corporation, and the third in the list is here ably treated by Mr. Homersham.

This production is illustrated by an admirable map, showing the situation of the proposed works, with a section from the wells at Bushey Meadows, near Watford, to Oxford Street, through the Stanmore Heath and Child's Hill reservoirs, and the line of main pipes. At this distance we cannot presume to enter into or discuss the relative merits of the different plans; but Mr. Homersham's report, irrespective of its peculiar application to the metropolis, is worthy of careful attention, as a contribution to our stock of information on sanatory matters.

Mr. Barlow's report, with a copy of which we have been favoured by Mr. Homersham, has arisen out of the proceedings taken by Mr. Barlow, as engineer of the South Eastern Railway, in obtaining a supply of water for the locomotives of the line. From the observations made under these circumstances, he has come to the conclusion, that the district through which the North Kent line passes, will yield a quantity of spring water sufficient for the supply of all London and the towns along the line. He says,—

"The abundance as well as the good quality of the water from the chalk, has been proved in every case where the water has been required by the South Eastern Railway Company, and seven out of ten of their locomotive water stations are thus supplied.

"At Folkestone, where great inconvenience from a scarcity of good water was felt, the water which percolates through the Martello tunnel is now conveyed to a reservoir, and not only supplies the Pavilion Hotel and the Steam Packet Company's ships and property, but also will afford an ample supply for the whole town.

"At Dover station the water is also supplied by a spring, termed the Lyddon Spout, situated between Dover and Folkestone, which yields water in such abundance that the requisite quantity to supply the locomotive engines is obtained by raising one-sixtieth part fifty-five feet high by an hydraulic ram, whence it is conveyed to Dover by pipes.

"The quantity from this one spring has been measured by me, and amounts to above one million gallons per day.

"On the North Kent line the locomotives are also supplied with water from the chalk, both at Gravesend and Strood; at the latter station, the water is conveyed in pipes from the Higham tunnel, where powerful springs, yielding 300 gallons per minute, are intersected above high water-mark.

"At Erith, Plumstead, Woolwich, and other parts of the line, an abundance of water is found at a few feet from the surface. In the Plumstead Marshes, springs, yielding from

200 to 250 gallons per minute, appear on the surface of the ground in the line of railway. In the Charlton Marshes springs also occur, yielding above 200 gallons per minute; and at the Abbey Wood station, in a boring of 30 feet, the water rises above the surface; and near Northfleet, a group of springs has since been measured, and ascertained to yield from 5,000 to 6,000 gallons per minute, the whole being again absorbed in the porous strata.

"I also observed the remarkable fact, that between Lewisham and Strood (twenty-six miles), only one stream which has its source in the chalk district (viz., the Cray) crosses the line of railway from the hills to the south, which led me to the examination of the south bank of the river Thames, with the view of ascertaining whether the water of the district between the railway and the North Downs drained into the river between high and low water-mark; and, from the observations made by me at Woolwich and Erith, I am convinced that this is the case, and that the absence of streams on the surface is to be explained in this way.

"The thickness of mud overlaying the chalk prevents the smaller springs from appearing; but at Erith, several powerful springs are seen, one group of which I measured, and found 500 gallons per minute flowing from it. Within 100 yards other powerful springs are visible, which I did not measure, but have no hesitation in stating that a quantity of water, exceeding 1,500,000 gallons per day, escapes in a length of 250 yards of the river bank."

Taking these data as being accurate, Mr. Barlow shows a very promising case for the especial attention of this line of railway; and as his estimate for bringing the water to the Bricklayer's Arms terminus is only £150,000, including making a heading to intercept the water flowing from the chalk district into the river, it has certainly economy on its side.

Outlines of Physical Geography, descriptive of the Inorganic Matter of the Globe, and the Distribution of Organized Beings. By Edward Hughes, Assoc. Inst. C.E. Pp. 188. Longmans & Co.

A Manual of Explanatory Arithmetic. Pp. 44. Same Author.

These volumes would alone form a very clear exposition of Mr. Hughes' qualifications as a sound and trustworthy instructor of youth, had we not reason to recognise his standing in this respect for other and more practical reasons. The first of the two, is intended "to present to young persons, a systematic account of the physical condition of the globe we inhabit," presenting a careful generalization of well-ascertained facts, with the results of the observations of modern philosophers. Such of our readers as have felt any interest in our own outlines of "Physical Geography,"* will see how efficient such a volume, well-arranged, must be, in the hands of the instructor of youth. Such a book must speedily take the place of the crude collection of names, and vague statements, which we connect with our own school days, and are grieved to find yet far too common. The coloured engraved maps which accompany Mr. Hughes' text are beautifully finished, and bear the name of Mr. W. Hughes.

The "Manual of Arithmetic" by the same author, carries with it the marks of a like careful compilation. It embodies "questions framed upon the occurrences which arise out of the ordinary requirements and occupations of daily life," and is, consequently, an essentially practical production. Another valuable feature in it is, that the compound and simple rules are jointly explained.

Both works will be found useful, not for school teaching only, but for something more.

Photogenic Manipulation. Part I. By R. J. Bingham. Pp. 72. London: Knight & Sons, 1850.

The significant "sixth edition," on the cover of this little hand-book, is of itself a speaking evidence of its value. To such testimony what can be added by the reviewer?

The original appears to have been carefully revised for the present edition, which therefore presents a fair detail of this elegant art as it now exists, under the many recent improvements. From amongst the most notable additions, we may extract the section descriptive of

PHOTOGRAPHY ON GLASS.

"Some time ago, Sir John Herschel, in his experiments with photographic agents, found that glass plates might be made use of with advantage for supporting the film of sensitive matter; his method of proceeding was to pour into a deep vessel a solution of salt extremely diluted, and then to add to this a very small quantity of the nitrate of silver, so as to obtain a liquid only slightly milky; and, at the bottom of this vessel, he laid horizontally a glass plate, and allowed the chloride to become very slowly deposited; the liquid was then carefully drawn off by means of a syphon, and the last portions by a little tow or blotting paper: when this was dry, he had a pure and uniform film of the chloride of silver. This plate was then placed at a very small inclination, and a weak solution of the nitrate of silver poured upon its upper edge; it flowed over the whole surface, and was allowed to drain off at one of the corners: this glass was then placed in the camera in the same manner as we should a daguerreotype plate; it was moderately sensitive, and darkened to a good black in a short time.

"Sir John Herschel observes, that 'if we wash pictures obtained in this way with the hyposulphite of soda they disappear, but this is only whilst they are wet; for, upon washing with pure water and drying, they are restored, and assume when laid on a black ground much the appearance of a daguerreotype, and still more so when smoked at the back, the silvered portions reflecting most light, so that the character is changed from a negative to a positive drawing. To obtain delicate pictures, the plate must be exposed wet, and when withdrawn, should be immediately plunged into water, that the nitrate of silver which is liable to crystallize may be abstracted.' This process, however, is rather troublesome, and the choloride or iodide is very liable to come off the plate in the various washings to which it is necessary to subject it; neither are the shades sufficiently intense to obtain a good positive picture. We have made many experiments on this subject, and have lately produced several negatives on glass which appear very promising. By one of the following processes very good results may be obtained:—

"*First Process.*—Beat for about ten minutes the whites of two or three eggs, then cover up the vessel, and allow the froth which is produced to resume the fluid state; pour a little of this liquid upon a piece of clean glass (previously adjusted by set screws to a perfectly horizontal position), and spread it evenly over the surface, using the edge of a piece of smooth and clean writing paper for that purpose; allow this layer of liquid to get quite dry, and then submit it to a heat of about 212° for two or three minutes: now prepare a solution of nitrate of silver containing 200 grains to 4 ounces of distilled water; pour this into a shallow dish, and then suddenly plunge the plate of glass into it; the solution should run over the whole surface at once, otherwise the coating will not be uniform: take the plate out and rinse it for a second or two in a basin containing distilled water; and then put into a dish containing a solution of iodide of potassium, containing 10 grains to 1 ounce of water, let it remain for a minute, and then again wash it well in distilled water for about ten minutes; the glass must then be taken out and suspended by one corner and allowed to dry; a number of glasses may be thus prepared and kept until required for use. To render the plate sensitive it is immersed into a solution of gallo nitrate of silver, prepared as described for the ordinary calotype process at § 51; this should be diluted about twenty times; let the glass remain in the dish about three or four seconds, then take it out and shake off the superfluous liquid; it is now very sensitive to light, and it may be used either at once, or it may be kept without spoiling for ten or twelve hours. After the picture has been impressed in the camera it may be brought out by pouring over it gallo nitrate of silver (§ 54); as soon as it is fully developed it should be washed in a little water, and then placed in a solution of hypo-sulphite of soda (§ 56) for about ten minutes, and afterwards washed in a quantity of common water and dried in a warm place.

"Beautiful positives may be obtained from these plates, having a degree of delicacy which cannot be attained in any other way; the process for obtaining the positive picture is precisely the same as that from a paper negative (§ 57); but the positive picture may be produced upon another piece of glass prepared in the same way.

"*Second Process.*—Obtain some very clear and good isinglass, pour on it a little hot water, so as to produce a thick jelly; while this is still warm and fluid, mix with it a few drops of a strong solution of the proto-iodide of iron, pour a little of this mixture over a piece of glass, and drain off the excess at one corner; allow this to get perfectly dry and hard, then suddenly immerse it into a solution of nitrate of silver, containing 100 grains, in two ounces of distilled water; it is now sensitive to the action of light, and should be at once placed in the camera. A very slight picture will, perhaps, only be visible; but it may be fully developed by putting it into a solution of the proto-acetate of iron, containing a small excess of acetic acid. As soon as the picture is fully developed, it should be rinsed in a little water, and fixed with hypo-sulphite of soda, as in the preceding process.

"We may, in place of the gelatine (isinglass), employ a number of other substances to form an adherent film upon the glass. The following are a few of those we have experimented with, and found to answer moderately well:—Vegetable gluten, dissolved in acetic acid, forms a very tenacious coating, and difficult to remove. Collodion (gun cotton dissolved in ether)—the spirit of wine varnishes—a mixture of albumen and gelatine, in equal proportions, applied as directed for albumen alone in the first process, and then immersed in an infusion of oak bark, several of the gums, starch, casein from milk, vegetable albumen, &c. The method of applying the solutions may be varied in a number of ways, and opens a wide field for experiment. When starch is used as a film upon the glass, the iodine and bromine requisite for converting the nitrate of silver into the iodide or bromide may be advantageously applied in the state of vapour as in the daguerreotype process; if a plate of glass, covered with starch, be exposed to the iodine vapour, it will gradually assume a fine violet colour from the formation of iodide of starch. When this is immersed in the nitrate of silver, the violet colour disappears, and is replaced by the pale primrose of the iodide of silver. If the starch plate is exposed to bromine, a red colour is produced, and, on immersion in the nitrate solution, disappears, and the white bromide of silver is produced. We are still experimenting on the subject, and hope to be able, before the summer weather arrives, to publish a process equal in sensitiveness to the daguerreotype."

It may interest those who have not seen the earlier editions, to have some idea of the nature of the author's treatment of his subject. The arrangement comprises a condensed history of the art, with practical information on the apparatus and materials—methods of preparing the paper—making the photographs—camera pictures—with no fewer than eleven different photographic processes.

The amateur will find the book a faithful guide.

Extraordinary New Steam Engine.—The Balance Engine and Locomotive: By which a Steam Vessel will only consume One Hundred tons of Coals during the same time that, with other Engines, she would consume Four Hundred tons; besides including an immense economy in the cost and wear of Boilers. By G. Overend, Greenwich. Pp. 14. Jersey, 1848.

Such is the title of the most curious piece of printed paper—for we cannot dignify it with the name of book or pamphlet—that ever tortured our reviewing nerves. Arguing on a total misconception of the action of the ordinary single-acting Watt's pumping engine, the unfortunate author has been led into the perpetration of a peculiarly rich specimen of absurdity. In opening his case, he states, that in the single-acting engine, steam being admitted to the upper side of the piston whilst there is a vacuum beneath it, the piston descends, raising the weight on the opposite end of the beam. When the piston is at the bottom, the steam in the cylinder being admitted to the bottom of the cylinder beneath the piston, there is an equality of pressure on each side, and, consequently, the weight on the beam raises the piston again. "This engine," says the author, "suggests important truths;" and we agree with him that, like any other simple mechanical movement, it does, and heartily commiserate him on his unfortunate lot in not meeting with any of them. Relying upon what he appears to conceive an inherent essence of power

* Pages 149 and 202, vol. ii.

in the continual change from a balanced to an unbalanced steam pressure, he proposes to carry out the system by the use of three cylinders, placed in a line. The centre one, which is the smallest, he calls the *active* cylinder, and it acts as a common condensing engine. The cross-head of its piston-rod is made long enough to reach to the piston-rods of the other two cylinders of larger size, the latter being filled with steam above and below their pistons. The working of the central cylinder, then, carries up and down with it these two pistons, pushing them back and forward through the steam. In this way he continually destroys, as he says, the balance of pressure, and obtains power from all the cylinders with an expenditure of steam only in the small one.

We need add no comments on this ludicrous notion; indeed, we have to apologise for troubling our readers with a single line about it, but as the author has begged our mention of it, we trust he is now satisfied. As a curiosity alone, it deserves registering amongst our reviews.

Weale's Rudimentary Works. — Tubular and other Iron Girder Bridges. By G. D. Dempsey, C.E. Woodcuts, pp. 132. Rudimentary Dictionary of Terms. Part III. London, 1850.

This is another instalment of Mr. Weale's useful little treatises. The first is a pleasantly written sketch of the history of iron bridges, with remarks upon the works of the different engineers who have contributed to the introduction of the material now so largely used in modern construction. The bulk of its contents are, however, devoted to a detail of the Britannia and Conway bridges. This portion is profusely illustrated with woodcuts, and is, upon the whole, a faithful account of the great tubes. The second follows up parts I. and II., already noticed in this *Journal*, and, as far as it goes, will be a useful assistant to the scientific reader. Of the impolicy of attempting to compress an undertaking of this sort into so small a space, we have already expressed our opinion

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An Account of Several New Patent Processes for Purifying the Water of Cities, Towns, and Private Dwellings. By John Horsley.

We have already introduced Mr. Horsley to our readers, by a short notice in Part 24. In reference to the purifying process described in the specification previously quoted, the author observes:—

"The object of this invention being to purify and soften "hard" water, which is of a very variable character, it becomes necessary, before treating any water according to this invention, correctly to ascertain the character or "hardness" of such water: and this I effect by first treating a given quantity thereof with an excess of oxalate of ammonia, or oxalate of potassa (that is to say, if the quantity of water be one gallon, then I use two drachms of the oxalate, which is an excess), precipitating the adventitious matter or lime to the fullest extent. For every gallon of this precipitate, when obtained and dried, an equal portion of crystalised oxalic acid is to be used, in order to purify the water; for example, say that a gallon of any water yields in this way fifty-six grains of precipitate, then fifty-six grains of the acid should be used along with an equivalent of potassa; there will then remain in the water, after precipitation, instead of and in place of the lime so displaced, a carbonate, sulphate, or muriate of potassa, as the case may be, and the water is purified and fit for use."

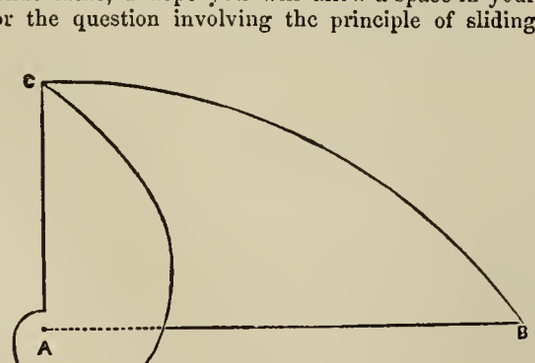
Some excellent remarks on filters, washing powders, liquids, and boiler incrustations, fill up the remainder of the pamphlet, which is worth attention in these times of sanatory reform.

CORRESPONDENCE.

DIFFERENTIAL SLIDE MOTION FOR LATHES.

As the following beautiful differential motion for sliding the connecting-rods of steam-engines, and similar parts, may, at a slight expense, be attached to any slide lathe, I hope you will allow a space in your valuable *Journal*, for the question involving the principle of sliding geometrical curves.

Let the longitudinal traverse of the slide rest along the bed of the lathe, from A to B, be equal to half the length of the connecting-rod to be slided. A C, A spiral attached to the screw of the slide-rest for producing the requisite variation of the screw, by its circumference being coincident in all its points with the line, B C, in traversing the distance, A B. It is now required to find the nature of the geometrical figure, A B C, and also that of the spiral, A C, so that the screw of the rest may be varied, in order to produce either a cone, segment of a circle, parabolic, or logarithmic curve upon the barrel of the connecting-rod.



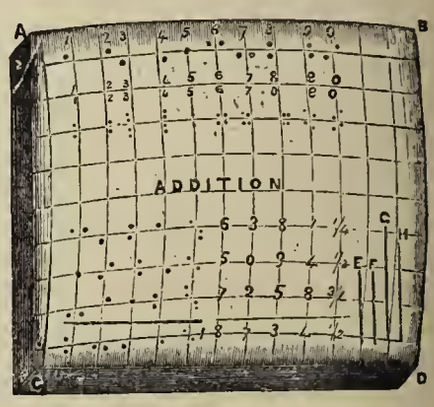
Robert Muckelt.

Crewe, March 30, 1850.

NEW ARITHMETICAL NOTATION FOR THE BLIND.

The idea of using common pins and a pincushion for the purpose of numerical notation in teaching the blind arithmetic is not new, having been suggested by Mr. Gall some years ago. It has not, however, met with the general adoption to which its simplicity and economy entitle it. Mr. Alston's perforated slate, although very efficient as far as it goes, does not meet the difficulty of expressing fractions, and, moreover, is expensive. The method here suggested is exceedingly simple and economical; and, at the same time, may be employed in complicated sums and fractions.

A B C D, Is a pincushion of any convenient size, covered with a corded cloth prepared for the purpose. The vertical and transverse lines represent the cords, which are sufficiently raised above the surface to be appreciable to the touch. The dots represent the pins thrust into the cushion up to the head, and correspond to the numbers written over them. The position of the pins, relative to the cords, is such, that each figure can readily be distinguished from all the others. The upper row represents the integral figures, from 1 to 0; the lower row shows the position of the pins intended for fractions: for these it is, of course, necessary that pins standing for all the figures, from 1 to 0, should only occupy one side of the transverse cord—the cord itself being the line between the numerator and denominator. For the sake of distinction, the pins for the fractions should either be a little smaller, or have a differently shaped head. E F G H, are pieces of wire of different lengths, to be used for strokes, as represented in the sum of addition. A supply of these is kept in a corner of the pincushion. This apparatus, as used by the blind, answers the purpose of a slate.



In constructing an apparatus for the use of the blind, it is of great importance that simplicity and economy be attended to, in order that it may be within the reach of all. Some of the inventions for the blind are so expensive as to preclude the possibility of their being obtained by those of limited means.

The system here described is extremely simple, and the apparatus is one which any one could make. It is easily learned; an hour's practice will suffice to enable any one to distinguish the figures from one another.

Were it generally adopted, a supply of the corded cloth, which is made for the purpose, might be kept at the various institutions, and supplied to those who wish to make the *slate* for themselves.

Robert Foulis, M.D.

Bruntsfield Lodge, April, 1850.

REGULATOR FOR CONTRACT GAS-LIGHTS.

I have all along foreseen the apparent objection noticed in your remarks on my "regulator," published in Part 25 of the *Practical Mechanic's Journal*, but the matter is easily set right. Let us suppose it to be requisite to have a pressure at the works, of $\frac{11}{10}$ths of an inch of water, to insure the proper supply to meters in all quarters, but that this pressure must be reduced $\frac{2}{10}$ths, to cause the instrument to perform its functions properly. All that is requisite, then, is to make the initial pressure $\frac{13}{10}$ths, or $\frac{2}{10}$ths more than is absolutely necessary. The removal, then, of this extra $\frac{2}{10}$ths brings the shut-off action into play, and the meters have still the proper amount of pressure for their supply.

Dumfries, April, 1850. James Kirkpatrick.

[We suspect this arrangement will leave the matter as it was before. If two pressures are used, whatever these pressures may be, the variation must be accounted for by a suitable adjustment of the consumer's stop-cocks. If $\frac{11}{10}$ths pressure is enough, then $\frac{13}{10}$ths will be more than

enough, and a stronger flame will be given at the burners by the greater pressure—*ergo*, if the flame is to be kept steady, the supply must be partially reduced at the stop-cocks, to bring down the superfluous pressure. We did not state, and are not prepared to assert, that this difference in pressure will actually prove a very grave objection; but that our correspondent does acknowledge it to be an inconvenience, is evident from the proposition he makes for its removal—a proposition which, by the way, only further illustrates our point. Apart from this, the apparatus is ingenious and effective.—Ed. P. M. Journal.]

SKETCHING APPARATUS.

I should feel much obliged if you would take the trouble to inform me, which of the numerous inventions for assisting persons to make representations of objects on paper, most combines the desiderata of accuracy of drawing, easiness to work, portability and cheapness. I am quite puzzled amongst the camera obscuras, camera lucidas, stereoscopes, goniometricons, and other instruments which I see mentioned in print.

April, 1850. A Sketcher.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

March 12, 1850.

William Cubitt, Esq., President, in the Chair.

It was announced from the chair, that copies of the ground plan of the intended site in Hyde Park, and of instructions for preparing designs of the buildings for the Grand Exhibition of 1851, had been presented to the Institution, and that, on application to the Secretary, duplicates of these documents would be forwarded to any of the members, who intended to devote their attention to the consideration of this question.

The paper read was, "On Tubular Girder Bridges," by Mr. William Fairbairn, M. Inst. C.E. The author commenced by stating, that the chief points to be taken into consideration were:—First, the application of a given formula, for computing their strength; Second, the excess of strength that should be given, over the greatest load that could be brought upon the bridge; and, Third, the effects of impact, with the best mode of testing the strength, and proving the security of the bridge.

In the first place, it had been determined by experiments, that, in order to balance the two resisting forces of tension and compression, in a wrought-iron tubular girder, having a cellular top, the sectional area of the bottom should be to the sectional area of the top, as eleven to twelve; and that until this proportion existed, the usual formula could not be applied; this formula was, that the breaking weight was equal to the total area, multiplied into the depth, and into a constant (80), and divided by the length of the girder $\left(w = \frac{adc}{l}\right)$

Considering the particular case of the Torksey Bridge, the mean sectional areas of the top and the bottom, being respectively 51·08 square inches and 54·93 square inches, the latter was in excess of strength over the former, so that a reduction of the area of the bottom from 54·93 to 46·76 square inches might have been made with propriety, and would have been in conformity with the formula.

By calculation, the ultimate strength of the bridge was found to be 1152 tons, whilst the greatest total load, including the weight of the girders, &c., was only 372 tons; this gave a strength greater than the heaviest rolling load that could be brought on the bridge, in the proportion of nearly five to one. Although, therefore, the proportion of the girders was not exactly that which the author recommended, he considered that "they were, nevertheless, sufficient to render the bridge perfectly secure." This conclusion was arrived at, without taking into consideration the amount of additional strength derived from the continuity of the girders, across the central pier.

The exact proportions recommended were given in two tables extending respectively to spans of 150 feet, and of 300 feet. The depths of the girders of the first class were taken at one-thirteenth of the span, and those of the second class at one-fifteenth of the span.

The author then investigated the effects of impact at different velocities. It did not appear that experiment established the fact of increased deflection at high velocities, for in several experiments on a large scale, he had found the deflection as nearly as possible the same at all velocities. He concluded by recommending, that the tests to be applied should never exceed the greatest load the bridge was intended to bear.

In the opening of the discussion by Mr. Fowler, Mr. Bidder, and Mr. Eaton Hodgkinson, it was remarked, that satisfactory as it was to have the confirmation of Mr. Fairbairn's authority, for the perfect safety of the bridge for all purposes of traffic, it would have been desirable, that he should have extended his calculations a little further, into the question of the increased strength derived from the continuity of the girder, across the central pier, which augmented the total strength fully one-fourth. It was also argued, that the excessive proportion of the bottom of the girder, although not an economical disposition of material, was in itself an important addition to the strength of the girder.

The definite proportions assigned in the paper for girders were disputed, and the attempt to assign empirical rules for the practice of engineers, in structures of this novel character, was earnestly deprecated.

It was important also to remember, that the large proportion of the bottom of the beam brought into action a corresponding quantity of the upper part of the side plates, in aid of the top. Thus it appeared, that if the subject had been pursued further, the proportion of five to one, by which the proportional strength of the beam over the rolling load was represented, would have been, from various causes, materially increased.

March 19.

The discussion on Mr. W. Fairbairn's paper, "On Tubular Girder Bridges," was renewed, and continued through the evening.

The subject was resumed at the point where it was left on the last discussion of March 12th, and Messrs. Wild, Pole, Rennie, Scott Russell, Eaton Hodgkinson, Walker, Glynn, Bidder, Professor Willis, General Pasley, and Captain Simmons, R.E., examined the question at great length, and under all views, illustrating their position by diagrams and models, used in the experiments and in the mathematical investigation.

It was stated, that after the remarks made at the last meeting, it was merely requisite to describe the experiments alluded to, and before doing so, to briefly describe their object.

In the Report of the Government Inspector, the limiting strain required for the public safety was defined, and the Torksey Bridge had been condemned for not complying with those conditions. A calculation, therefore, had been made to ascertain the actual strain on the bridge. It appeared, however, that it was really *less* than the limit prescribed by the Government Inspector. The experiments instituted were for the purpose of testing these contrary results. It was also stated, that in the paper there were many objectionable points, but particularly one that was positively dangerous.

The author had not only omitted the effect of the continuity of the Torksey girders, but stated, that it was *safer* to do so. Now all writers upon the subject, and all who had considered the matter, agreed that in a continuous beam the effect of continuity was most important, and that in a *perfectly* continuous beam, the strain over the supports was even greater than elsewhere. It was therefore submitted that this was not the part, the consideration of which it could be "safer to omit."

The form taken by a continuous beam, when uniformly loaded, was convex over the supports, and concave between the points at which the convexity ended; at these points of contrary flexure, the horizontal strains were null, and the beam might then be severed, without altering its condition. The virtual length of the beam, in the Torksey Bridge, was determined by the distance between the exterior support and the point of contrary flexure; and it was to determine this point practically, that the experiments were instituted. It was shown that this point was 21¾ feet from the centre support, and that hence the length of the beam was reduced from 130 feet to 108¼ feet.

The compressive strain upon a girder of this length, loaded as prescribed, was 4¾ tons per inch, being less than the limit defined. Consequently, it was asserted, that the Railway Company to whom this bridge belonged, had been deprived of its use, not in consequence of any omission on the part of their engineer, but in consequence of the inability of the Government authorities to appreciate the strength that had been provided.

In reference to the application of formulæ to the calculation of the strength of the girders, it was considered desirable, in such an important case, not merely to form a general approximate notion of the strength of the bridge, but to ascertain, with all possible exactness, the nature and amount of the strains to which the structure was exposed; and this could only be done, by using a comprehensive process of calculation, which should embrace all the elements affecting the strength of the bridge.

The effect of the continuity of the girders over the two openings was carefully considered, and the nature of its effect upon the strain was explained, as deduced from the application of the most modern mathematical investigations, and it was demonstrated that the strength of the beam was thereby augmented above one-third.

It was then shown, how the rules for estimating the strength of elastic beams were rendered applicable to the case of the Torksey Bridge, and the results proved, that when the bridge was weighted with the load prescribed by the Government authorities as a test for its strength, the strains of compression and extension were only one-half of what competent authorities had stated might be safely applied.

The diagrams exhibited, showed the results of mathematical calculation, as applied to the Torksey Bridge girders, and the remarkable coincidence of these, with experimental results obtained by other investigators in an entirely different manner, was insisted on, as a proof of the correctness of the conclusions arrived at.

It was stated, in reply to a remark upon the increased deflection due to velocity, that the result of the experiments tried by the "Cast-Iron Bridge Commission," proved, that "this increase was wholly insignificant in beams of the length and stiffness of those of the Torksey Bridge."

The discussion was summed up by its being stated, that, with one exception, all those who had spoken during both evenings, agreed that the formula given in the paper was empirical and not trustworthy; that the effects of percussion and increased velocity were practically only shadowy visions; and as it was admitted, that in the calculations of the Government Inspector, the effect of continuity was neglected, and as it had been proved, that the strain was less on the bridge than that assigned as requisite for the public safety, and that it was, in fact, amply strong, it was evident, that the public had been wrongfully deprived of the use of this bridge, and the Company had been prohibited from gaining the just return for the capital invested, in consequence of an incomplete investigation, and the assumption of untenable formulæ.

March 26.

"Description of the Chapple Viaduct, upon the Colchester and Stour Valley Extension of the Eastern Counties Railway," by Mr. P. Bruff, Assoc. Inst. C.E. This viaduct was thrown across the valley of the Colne, at Chapple; it consisted of thirty-two semicircular arches, each of the span of 30 feet, the total length being 1136 feet, and the extreme height from the foundations to the rail level being 80 feet. The average height of the piers from the foundation to the springing was 45 feet; they were 27 feet 3 inches wide, by 4 feet 10½ inches thick, at the under side of the impost, and tapered downwards to the plinth, with a batter of 1 in 36; twenty-three of the piers only had plinths, which consisted of a set-off of 2¼ inches, making the dimensions of the base of those piers 29 feet 6 inches wide, by 7 feet 1 inch thick. The piers were solid below the plinth, but above that level there was a centre opening 6 feet in width, arched at the top and the bottom. The whole of this viaduct was constructed of bricks made in the district, being chiefly set in mortar, but the arches for a distance of 4 feet 6 inches above the springing were set in cement. The viaduct occupied about 20 months in construction, and cost about £55 per lineal yard.

The next paper read was, "On the Manufacture of Malleable Iron, with the results of Experiments on the strength of Railway Axles," by Mr. G. B. Thorneycroft, Assoc. Inst. C.E. It was stated that malleable-iron might be divided into two distinct classes, "red short," and "cold short;" the former being generally produced from the rich ores, and the latter from the poorer, or leaner ores. The pig-iron made from the rich ores (under the cold-blast process only) was not so fluid as that from the lean ores, but when converted into malleable-iron it became tough and fibrous, though it was troublesome to work at less than a white heat, which had caused it to be denominated "red short." On the other hand, the pig-iron produced from the lean ores possessed greater fluidity, but when malleable it was unfitted to support sudden shocks, or continuous strains, and was hence termed "cold short." It was further stated, that in the manufacture of malleable-iron very much depended on the quality of the fuel used in the smelting furnace, and in the subsequent processes; also that iron became crystalline from two causes—first, in consequence of being made from naturally cold short pig-ron; and secondly, from a peculiar manipulation during the process of "puddling."

The introduction of hot blast for smelting iron, rendered necessary a careful investigation of the comparative use of hot and cold blast pig-iron, in the manufacture of bars, from which it appeared, that if the same quality of materials was used in both cases, equally good bar-iron would be produced, though it was more difficult to convert hot blast pig-iron into "number one" bars, and the waste was greater. It was certain, that whilst good grey pig-iron could only be produced, by cold blast, from the best materials, iron of apparently excellent quality could be made, by hot blast, from the most sulphurous ores and fuel; indeed, to this alone must be attributed the bad reputation of hot-blast iron for certain purposes.

As it had been asserted that the peculiar characteristics of malleable-iron were to be attributed to the ore from which it was produced, and not from the different nature of the processes used in its conversion, which the author had always believed to be the true cause, he had, at his works near Wolverhampton, made bars of the finest crystalline and of the strongest fibrous texture from the same Yorkshire pig-iron. Another cause which induced great changes in the texture of iron, when cold, was compression, or impact, which would completely alter its texture from a fibrous to a crystalline character, as was well exemplified by the "gag," and the puddling tools used by forgemen, and in several parts of different kinds of machinery the same effect was observed.

The author then proceeded to draw attention to the best shape for railway axles, so as to combine the greatest strength with the least material, illustrating his views by the details of experiments made for determining the question. It would appear that railway axles should be made parallel, from journal to journal, without any shoulder, and with just sufficient strength to prevent any vibration in rotating. The experiments showed, that an axle without a shoulder was better able to resist impact than one with a shoulder, in the ratio of 155 to 55, and by leaving the axle parallel its strength compared with the same sized axle reduced in the middle was as 5 to 1½.

April 2.

In the renewed discussion upon Mr. Thorneycroft's paper, "On the Manufacture of Malleable Iron, and the Strength of Railway Axles," it appeared to be admitted, that the shoulder on axles was only useful as a guage, and that it should be curved from, and not square to, the main body; that between the journals, the axle should be parallel, for if reduced in the centre, it was sure to bend, and eventually to break. Since the last meeting, Mr. Thorneycroft had made many other experiments, which proved his former opinion, relative to the progressive changes in iron, from compression, which alone caused the destruction of the fibre, and, in fact, that jarring would not do it. Experiments were suggested to ascertain, whether a pressure on the periphery of a wheel, fixed on an axle and kept rotating, would produce the same results, which were admitted to exist in practice.

"Description of a Lift Bridge, erected over the Grand Surrey Canal, on the line of the Thames Junction Branch of the London, Brighton, and South Coast Railway," by Mr. R. J. Hood, M. Inst. C.E.

The act for the construction of this branch, which was a single line, one mile in length, provided that the crossing of the Grand Surrey Canal should be by a swing bridge; but as there were many obstacles in the way of this clause being carried out, and as it was not thought to be the most convenient form of construction, it was determined, after due consideration of the advantages and disadvantages of each particular kind of moveable bridge, to erect one on a principle which might be designated a "Lift Bridge." This consisted, simply, of a rectangular platform, 23½ feet in width, and 35 feet in length, carrying on one side a line of rails, and on the other side a roadway for carts; it was formed of four beams of oak timber, undertrussed with wrought-iron rods and cast-iron saddles, those for carrying the rails (which were bridge-shaped) being stronger than the others, and having a flooring of 3-inch planking; the platform rested, when down, upon piles driven into a bed of hard gravel, met with at a depth of about 20 feet below the water line. The platform, which was about 12¾ tons in weight, was suspended at the four corners, by galvanised wire ropes, four inches in circumference, attached to the end of each oak transom, by means of strong bow springs, and passing over pulleys, fixed on four pairs of cast-iron standards, also supported on piles, and fastened at the other end to drums, 3 feet in diameter, each pair of which were keyed on to the same horizontal shaft, situated a few inches under the rail and road level. Upon the same shafts there were also fixed six other drums, of a like diameter with the former, carrying, upon coils of wire rope, 2⅝ inches in circumference, balance weights, of a total weight of 12½ tons, but not equally distributed, intended to assist in raising the platform, and which descended in cast-iron cylinders, or wells. Motion was given to one end of each shaft, by means of simple hand-gearing, consisting of a train of wheels and pinions, by which the power was multiplied twenty-six times.

The level of the rails, above the water-line, was 4½ feet, and as the platform was capable of being raised 9½ feet, sufficient room was afforded for the passage of the barges, the greatest number of which ever passing through in the twenty-four hours being fifteen, and since the erection of the bridge, not one in a hundred had been detained one minute; though on this point, as well as on many others, the Canal Company had raised factious objections, owing to which, and to the design having to be submitted for approval to the Railway Board, great delay arose in the commencement, and also in the execution of the works, augmenting the actual cost to £1,300, which was beyond what it was presumed, a similar work could, under more favourable circumstances, and when the construction was not novel, be executed for.

The bridge was stated to have proved very successful, and in situations where only a given headway was required for a limited span, this kind of construction was recommended.

INSTITUTION OF MECHANICAL ENGINEERS.

January 23.

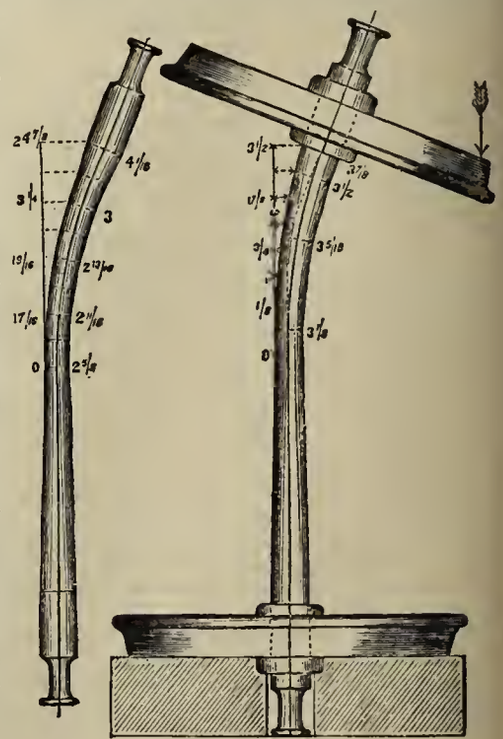
On the Deterioration of Railway Axles.

By Mr. M'Connell.

(Concluded from Page 21.)

In addition to various other experiments, with the view of determining the change which is gradually going on in Railway Axles, and other iron liable to a jarring, vibrating motion, the writer would refer the meeting to a few of the samples of broken axles sent to him from various quarters, which, if proof were wanting, completely substantiate, in his opinion, the certainty of the crystalline change.

Before reading some of the communications received from other gentlemen containing their experience on the subject, he would first call attention to the two experiments which were tried in relation to the proportion and form of axle, in order to meet the objection raised at the former meeting, "that the slow pressure on the flanches of the wheel to discover where the axles were most exposed to the bending strain, was not a faithful representation of what takes place in practice." The axle was fixed upright, so that the wheels were placed in such a position that the violent blow, when the wheels of the carriage jarred upon the rail, was fairly represented by the blow caused by the descent of a weight of 17 cwt., which was allowed to fall upon the edge of the wheel at A, from a height of 9½ feet. It is most satisfactory to find that the curve into which the axle was bent is quite in accordance with the former results,



Scale 1-24th.

No. 1. Axle bent by hydrostatic press, applied at the same point of wheel, A, as in No. 2.

No. 2. Axle bent by one blow from weight of 17 cwt. falling 9½ feet on the edge of wheel.

Axles proportioned according to the results of experiments.

which were obtained by slow pressure applied at the same points, and establishes the rule of proportion of the axle therein stated.

The following are some instances of tough fibrous wrought-iron being rendered brittle, and breaking off quite square with a close-grained fracture from the effect of the concussion of very small blows rapidly repeated for a long period; the blows being very small in force compared to the strength of the iron. These specimens are from the machines for making button shanks, in Mr. Heaton's Mills, Birmingham. The hammer in these machines is about 2½ lbs. weight, and is lifted by a rod ⅝ inch square, which has a pull upon it of about 12 lbs. from the difference of leverage; the hammer strikes 120 blows per minute, but the cam that drives it acts only during one-fourth of its revolution, so that the velocity of the hammer is equal to four times the number of blows, or nearly 1000 changes of motion per minute. The lifting-rods always break with a close-grained short fracture, although made of the toughest and most fibrous iron that can be obtained, and they sometimes last only a few months; the rods break near to the end, which is fixed with a coupling, and the deterioration of the iron appears to be confined within a small portion, the iron remaining quite tough and fibrous within an inch of the fracture, as shown by the specimen, which has been bent double at that part. The hammer is snatched suddenly by the lifting-rod, and is pulled against a strong spring for the purpose of getting a quick recoil, and a sharp blow of the hammer, much quicker than it would fall by gravity.

Another specimen from the same machines is the lever for pushing off the work from the machine when stamped; the lever is about ½ inch square, made of the toughest wrought-iron; it is 9 inches long, and falls back against a stop at one-third of its length from the centre of motion at the bottom, being thrown back sharply by a spring, the total strain upon the lever varying from about 1 lb. to about 12 lbs., according to the accidental circumstances in the working of the machine. These levers all break off quite short and close-grained within an inch of the part that strikes against the stop, but the iron continues quite fibrous and unchanged to within an inch of the point of fracture, as shown in the specimen. They were driven at the same speed as mentioned above, amounting to nearly the velocity of 1,000 changes of motion per minute; but they broke so frequently, lasting sometimes only a few weeks, that it was determined at last to reduce the speed of the machines from 120 to about 100 blows per minute, and in consequence of this reduction in speed the levers are much less frequently broken, and last on the average about four times as long as before.

Communication from Mr. JOHN KEKWICK.

"*The Holmes, Rotherham, 4th December*, 1849.

"I have read your able paper on Railway Axles, and I notice Mr. Robert Stephenson said that Mr. M'Counell had expressed a strong opinion that a change took place from a *fibrous* structure to a *crystalline* one during the time of its being in use, and it would be satisfactory if an instance could be pointed out where this change had occurred owing to vibration or other treatment.

"I think I can furnish an instance in proof of your opinion on this point.

"In one of our forges we are daily in the habit of using a metal helve or hammer weighing about 4 tons, for the purpose of drawing large sizes of steel, and the shaft of this helve is 17 inches by 9 inches. Finding great inconvenience and danger from the breakage of *cast*-iron helves, we were induced to try a *wrought*-iron one 16 inches by 8 inches. After using this for several months the shaft broke in two about the middle, and the fracture presented the crystalline appearance of 'short' cast-iron: we repaired the shaft, and in the course of a few months it again broke about the same place, and it again presented a similar granulated, cast-iron like, crystalline appearance throughout the face of the fracture. I attributed this change solely to the *vibration* and *jar* occasioned in the process of hammering steel, more particularly *cast* steel."

Communication from Mr. BENJAMIN GIBBONS.

"*Shut End House, near Dudley, 15th January*, 1850.

"When the heavy cast-iron helves were used for drawing out bars, and the art of *chilling* iron was little understood, the nose or that part of the iron helve struck by the cam to lift it was protected by a wrought-iron plate well fitted, and this was secured by a large pin countersunk into it, and extended through a hole cast through the nose of the helve, and screwed as fast as possible on the upper side. The very best and *most fibrous* iron (ascertained to be so by previous breaking) was always selected, and yet when the pin broke by the repeated shocks it had to sustain (about 90 times per minute), it always broke with a large bright grain, *without the least trace of fibre*. This was so regularly the case, that I never knew a pin last for many months.

"Another instance was in a fly-wheel where wrought-iron arms were used instead of cast-iron, for the purpose of throwing the weight to the outer circumference, and this wheel was applied to a forge-hammer engine. It worked well for a time, till the arms got loose in the cast-iron rim, and then a violent shock was received every time the cam struck the helve; after some time the arms began to break one after the other, and though the iron was of the toughest description originally, it was found that any part broken was of a bright crystalline grain.

"The pins of shears for cutting down large cold bars sustain violent shocks; they perpetually break with the same bright grain, though made of the toughest iron. Also the iron arms of common carts always break with that grain from the same apparent cause.

"I have taken iron of this bright crystalline character, which I had previously known to be fibrous, and by drawing it down a little at a proper heat have never failed to restore the fibrous texture of the iron."

The practical suggestions derivable from the foregoing experiments and inquiries, which are confirmed by all the writer's previous experience and information, are—

1st. That the axles of all railway engines, carriages, and vehicles should be made of the best ascertained quality of iron for the purpose, both tough and strong, and of uniform clean fibrous texture.

2nd. The proportion of an axle in all its parts to be determined from sound experience and calculation; the load it has to carry, the speed at which it is run, and the description of wheel in which it is placed, and strains to which it is liable in working from curves or inequalities of the road, or other deteriorating causes, being fully considered.

3rd. That previous to any axle being allowed to run on any line, the maker's name should be legibly marked thereon, and the date of manufacture, and also when it was first put to work. It is of course manifestly impracticable to record the number of miles run, but as all railway stock, in a general way, is worked nearly uniform, the above particulars would afford the necessary data to guide the opinion which may be formed, of the age beyond which limit the iron becomes comparatively unsafe.

4th. That it be part of the duty of the proper officer to see that all axles are working in good condition and receiving careful treatment.

5th. The next point the writer would press is, that all in whose power is the opportunity for registering facts in connection with railway axles, should, by this or some recognised scientific institution, be requested to note and carefully collect their information on all the points, in order that a certain average result for the guidance and benefit of all interested may be arrived at.

6th. That attention should be given to ascertain the description and working condition of wheels, which in all points cause the least deteriorating effects on the axle; and for this he proposes to produce some further experiments and also results from practice.

7th. That the quality of lubrication and description of bearings used should also be considered, and for this he also proposes to give a paper to the Institution, with the results of experiments and experience.

ROYAL SCOTTISH SOCIETY OF ARTS..

Address by THOMAS GRAINGER, Esq., C.E., President of the Royal Scottish Society of Arts, *on the desirableness of obtaining Communications relative to the construction and details of Engineering and other Public Works, accompanied by the necessary Models and Drawings.*

On taking his seat as the new President of this Society, Mr. Grainger delivered an address on this most important point—opening his subject, after a few preliminary remarks, by drawing attention to the Supply of Water for Domestic Purposes.

The epidemic which has recently visited us, has given this subject a degree of importance which it did not previously possess. Most of our large towns are now tolerably well supplied with water; but many of our smaller towns are very defective in this respect. It is well to urge the necessity of "being washed and made clean;" but such counsels are wholly unavailing, unless copious supplies of pure and wholesome water be provided at moderate charges.

The methods by which water is at present supplied to towns, may be comprehended in two classes: *First*, Where the source of the supply is sufficiently elevated to admit of its being discharged into the cisterns of the consumers by its own gravity. This is known as the "gravitation system." *Second*, Where the water is obtained from streams or springs situated *below* the level of the point of discharge, so that it becomes necessary to employ machinery to *raise* it to the required altitude.

The first of these is unquestionably that which should be adopted wherever it is practicable at a moderate cost. On this principle, that portion of Glasgow situated south of the river Clyde is supplied with water, and there is the prospect of its being extended to the other parts of that city. Greenock, Dundee, Dunfermline, Stirling, Kilmarnock, Paisley, Portsmouth, and Newcastle, are all supplied in the same way. But the gravitation principle has been carried out in greater perfection, in all its details, by the Water Company of this city, than in any other with which I am acquainted. A description of these works would be a most valuable contribution to the society; and there is no gentleman so well qualified to furnish it as the eminent engineer, Mr. Jardine, a fellow of this Society of long standing—whom I am happy to see present this evening—by whom the most important of these works were planned, and under whose immediate inspection the principal portions of them have been executed.

Of the six companies which supply London, five obtain water from the river Thames, and some of its tributary streams on the same level—an arrangement which requires the water to be pumped to the required altitude. The water supplied by the New River Company is brought into London by its own gravity. This is one of the oldest of the London Water Companies. At Perth and Aberdeen, and by one of the Glasgow Companies, steam-engines are employed for raising the water.

In some cases, too, as at Philadelphia and other places in America, the *power* required for working the forcing-pumps, is derived from the river from which the supply of water is obtained. Where this can be accomplished, it is generally found —whether considered with reference to the first cost or the current expenditure— to be the most economical plan.

Some towns, as Liverpool and New York, obtain part of their supplies from *wells*. At New York, the gravitation principle has recently been adopted on a scale of magnitude hitherto unknown, and has in a great measure superseded the use of *wells*.

This new supply of water for the city of New York is brought from the river Croton, a tributary of the Hudson, and passes along the left bank of that river.

It is conveyed nearly the whole distance of 40¼ miles by an open aqueduct, which is lined throughout with masonry. It is about 7 feet broad, and the water, in its usual state, is about 2 feet in depth. The fall on the whole course of this aqueduct is 47 feet, and the receiving reservoir at New York, from which the distributing pipes diverge, is about 115 feet above the level of the sea. There are several very interesting works connected with this undertaking, the chief of which seems to be the aqueduct over the Haarlem river, consisting of 15 arches, seven of these being 50, and eight of them 80 feet span! The height from the foundation in the river to the top of the works is about 150 feet.

The expense of the whole works has been about £2,400,000, an enormous sum, certainly, with relation to the present population of New York; but it is considered that the supply thereby secured is sufficient for one million of inhabitants.

Before leaving this branch of my subject, which concerns the health and comfort of so many human beings, I must advert to an exceedingly simple apparatus—*machine* I can hardly call it—for raising water where the required quantity is comparatively inconsiderable. I refer to the *hydraulic ram*. It is *self-acting*, and its first cost is trifling. It will raise water nearly 300 feet; but it is essential that there be 10 or 12 feet of fall, and that the quantity of water in the stream from which the supply is taken, should be about ten times that to be raised.

[We shall give the remainder of this address in our next number.—Ed. P. M. Journal.]

MONTHLY NOTES.

Ocean Penny Postage.—Although the debate on this question has been for sometime lulled, and the echo of Elihu Burritt's eloquent exposition of its advantages has died away, there is still some latent faith in the eventual fulfilment of the project. The post has brought us another mite of evidence of this fact, in the shape of a wood engraving of a pretty sketch on the face of an envelope. The drawing represents a steamer in full steam and sail, dashing on her course in fulfilment of her mission, as one of the links that bind together the people of distant climes; whilst in the dim far-off distance are seen the faint outlines of other ships, bending each its own course. The fore-sail of the steamer carries, in giant characters, the words, "Ocean Penny Postage," and her ensign and fore-topmast pennant each bear the sign "1d.," whilst the colour at her mainmast has the outline of a sealed letter in one corner. The view fills up the greater part of the left side of the envelope face, leaving an irregular blank for the address on the right. Above are the lines, "The world awaits Great Britain's greatest gift—an Ocean Penny Postage;" and along the bottom, "To make home everywhere, and all nations neighbours." The design is by H. Anelay, and the envelope is published by Charles Gilpin of London.

Armstrong's Water-Pressure Engine for Mines.—We have to record another practical application of the economical power obtained from hydrostatic pressure—which has been so well elaborated by Mr. Armstrong, in his hydrostatic cranes and stationary engines—in the actual introduction of a traction-engine for mines, in place of using horses or steam-engines below ground. This has just been carried out at Murton Colliery, belonging to the South Hetton Coal Co., the office of the engine being the drawing trains of coal waggons up an inclined plane, at a considerable distance from the foot of the shaft. The engine has four small cylinders, the diameter of each being three inches, and the length of the stroke twelve inches. The water which supplies the power consists of the drainings of the shaft, collected in a standage at a height of 606 feet above the level of the engine, to which it is conveyed by means of pipes 4½ inches in diameter. The bank up which the trains are drawn is 880 yards in length, and the gradient averages a rise of 1 in 30, but at certain parts it reaches 1 in 18. The number of tubs drawn in each train varies from 18 to 21, and the time occupied on the journey is from 4½ to 6 minutes. The average speed of the engine is about 100 revolutions of the crank shaft per minute, but a velocity of 130 strokes per minute is sometimes attained, without producing the smallest shock upon the engine. The perfect smoothness of the action is the result of the peculiar arrangement of valves, which our readers will find illustrated at page 244 of our first volume. The quantity of water expended during each journey is about 1,500 gallons, and the power of the engine is approximately estimated at 30-horse. The standage collects as much water as will draw twenty trains per day, and as the water has, under any circumstances, to descend to the bottom of the mine, its application to the engine does not increase the quantity to be pumped. The supply of water may be increased to any extent, but any extra quantity that may be required will involve additional pumping. The engine will ultimately draw fifty trains per day, but even when used to this great extent, the addition to the work of the pumping engine will only amount to about thirty gallons per minute, throughout the twenty-four hours. Both horses and steam-engines are objectionable in underground workings; it is therefore hoped that the coal trade will fittingly acknowledge the services of Mr. Armstrong, in devising and introducing so efficient a substitute; the spirit of the owners of Murton Colliery, for their spirit in being the earliest to adopt it; and the excellent arrangements of Mr. Edward Potter, the well-known viewer of the colliery, in connection with the working of the engine.

The Portsea Watt Institute.—The directors of this deserving institution are just now organizing arrangements for erecting a suitable building worthy of the name of a Watt Institute. The number of members at the present date is 240, the issue of books being at the rate of about 6,000 per annum. The routine of management is calculated on a sound liberal basis, and includes lectures, concerts, readings in the hall, with classes for rudimentary instruction in various branches. Amongst these are included drawing, modelling, and engineering. Mr. Andrew Murray, chief engineer and inspector of machinery in the dockyard, is the president for the time being; and under his care, with the attentions of the many gentlemen of high standing, whose names we find in the list of management, we may reasonably hope for the permanent well-being of the society.

Screw Steamer for Canals.—A small experimental screw steamer for canals, is now being tried on the Trent and Mersey Canal, under the auspices of Mr. Ricardo, M.P., the chairman, and Mr. S. P. Bidder, the manager of the North Staffordshire Railway. She has a four-horse engine, with an oscillating cylinder, the piston-rod being connected directly to the screw shaft, one end of which carries a fly-wheel. The boat carries 30 tons, and considering her small power, her performance is by no means bad. On the Thames, it is said, seven or eight knots per hour were got out of her, but in the canal trials with a load, her rate is said not to have exceeded 3¾ miles per hour. The boilers are tubular, and the whole machinery is comprised within a space not greater than that ordinarily taken up by the crew. We are glad to find the subject of steam propulsion on canals has not been entirely lost sight of, as it is pretty certain that something may be made of it.

The Floriform Parasol.—A writer in a late Number of the *Art Journal* threw out a hint for the improvement of the shape of these elegant accessaries to the lady's dress, in proposing that we should follow out a principle, found to hold good in many matters of greater moment, and select models from nature, as exhibited in flowers. That the suggestion is a good one, is evidenced as well by the many beautiful shapes of floral productions, as by the peculiar adaptability of a great variety of such shapes to parasolic purposes, and it is satisfactory to find that it has been put in practice in a very effectually pleasing manner. The "Floriform" parasol of Messrs. Morland & Son, of London, is a great advance in point of graceful form, upon the old and well-accustomed miniature umbrella, so long adhered to.

Willway's Phero-Pneuma, or Gas-Carrier.—This apparatus, which the inventor disguises under a monstrosity of a name, is intended for use where the gas-light requires to be moved from place to place, whilst the gas is burning. A wooden frame is fixed into the ceiling of the room, carrying a reel, or pulley, fitted to revolve on a horizontal axis. The gas is supplied by a flexible pipe, which is in connection with a short bent tube on the end of the pulley, this being again in connection with another flexible pipe winding round the pulley. The junction of the inlet flexible pipe, with the short piece fixed to the end of the pulley, is made to come close to the centre of motion of the pulley, so that as the latter is turned, it imparts little objectionable twisting strain to the pipe; the pulley passes down through the ceiling to the burner below. The effect of the contrivance is, that when the burner is drawn away, the flexible pipe unwinds from the pulley, and a small spring being attached to the latter, its reaction winds up the pipe when any slackness takes place.

Dr. Henderson's Planetarium.—A Manchester correspondent sends us some particulars of a very beautiful planctarium, recently completed by Dr. Henderson of Birkenhead, for exhibiting the equated sidereal revolutions of the planets in the solar system. The sun, in the centre of the arrangements, is represented by a gilt ball, three inches diameter, and the earth, by a terrestrial globe, one inch diameter. The rest of the planets are illustrated by ivory balls in proportion to their sizes. The mechanism of this very comprehensive model, involves the use of 103 wheels and 11 pinions, enclosed in a polygonal box of twelve sides, supported on an elegant tripod stand. The indefatigable constructor has spent the best part of three years on the necessary calculations, and our informant adds, that "it is stated by many eminent astronomers and mathematicians, to be truly surprising in accuracy, and never before have such extremely fine periods been reached."

English Commercial Enterprise.—We have a peculiarly good illustration of the indomitable spirit of enterprise of the promoters of our national commerce, in the fact that an English Company has been formed, and is now actively organising its resources, for the establishment of a steam flour mill at Smyrna. The present supply of flour is obtained from the numerous horse mills of the town, but these are quite insufficient to meet the demand, and the consequence is, that large importations of flour from the adjacent islands, and even from the interior of Asia Minor, are of constant occurrence. The new undertaking proposes to remove the difficulty in the way of obtaining a regular and cheap supply, by the erection of extensive grinding-mills, the engines and machinery for which, as noted by us in Part 24, have been made by Messrs. Joyce of Greenwich. For the protection of the interests of the Company, an *Imperial Firman* has been obtained, securing to the projectors an exclusive privilege for the use of steam mills for 15 years, within the Pachalic of Smyrna. It is a curious fact that to British engineers, so far distant a locality as Smyrna should owe its first steam grinding mill.

Simpson and Shipton's Improved Reciprocating Engine.—This ingenious invention, which we have figured and described under one modification at page 134, in Vol. II. of this *Journal*. At that time we promised some further notes of performance, to test which one of the new engines had been erected alongside a reciprocating engine of the ordinary class, both being driven from the same boiler. We now give the result of some very careful trials:—

Ordinary Engine, working 7 feet Fan, with 15 Arms; also, Clay Grinding and Sifting Mills.

1st. Commenced blowing 5 minutes to 3 p.m.; left off 25 minutes past 5 p.m.; consumed 10 cwt. of coal, viz., 5 cwt. in getting up steam, and 5 cwt. during the time of blowing, being 2½ hours; quantity of metal melted, 6 tons; Feb. 25.—2d. Commenced blowing 20 minutes to 3 p.m., left off 20 minutes past 5 p.m.; consumed 10¼ cwt. coal, viz., 5 cwt. in getting up steam, and 5¼ cwt. during the time of blowing, being 2 hours and 40 minutes; quantity of metal melted, 6 tons 13 cwt.; Feb. 27.—3d. Commenced blowing 25 minutes past 3 p.m., left off 5 minutes past 5 p.m.; consumed 7 cwt. of coal, viz., 3 cwt. (*boiler warm from being used in the morning*) in getting up steam, and 4 cwt. during blowing, being 1 hour and 40 minutes; quantity of metal melted, 4 tons 1 cwt.

	Cwt.	qr.	Tons	cwt.	qr.	
Coal consumed 1st experiment,	10	0	for 6	0	0	of metal melted.
" 2d "	10	1	" 6	13	0	"
" 3d "	7	1	" 4	1	0	"
	27	2		16	14	0

SIMPSON AND SHIPTON'S ENGINE.

1st. Commenced blowing 2 p.m. left off 5 minutes to 6 p.m.; consnmed 13 cwt. of coal, viz., 5½ in getting up the steam, and 7½ during the time of blowing, being 3 hours 55 minutes; quantity of metal melted, 7 tons 16 cwt. 2 lbs. 2d. Commenced blowing a quarter past 3 p.m., left off 5 minutes to 5 p.m.; consumed 5¾ cwt. of coal, viz., 3 cwt. in getting np steam (*boiler warm as before*, No. 3), and 2¾ cwt. during the time of blowing, being 1 hour 40 minutes; quantity of metal melted, 3 tons 16 cwt. 3d. Commenced blowing a quarter to 3 p.m., left off 3 minutes to 5 p.m.; consumed 8½ cwt. of coal, viz., 4½ in getting up steam, and 4 cwt. during the time of blowing, being 2 hours 12 minutes; quantity of metal melted, 6 tons 17 cwt.

	Cwt.	qr.	Tons	cwt.	qr.	
Coal consumed 1st experiment,	13	0	for 7	16	2	of metal melted.
" 2d "	5	3	" 3	16	0	"
" 3d "	8	2	" 6	17	0	"
	27	1		18	9	2

Showing a balance in favour of the new engine of 35 cwt. of metal for the same consumption of fuel. In No. 1 experiment, Messrs. Simpson and Shipton's engine had on an expansion gear, in the shape of a cam motion, attached to the vibrating side-rod, cutting off a boiler pressure of 42 lbs. at one-third of the stroke, and though the effect was good, more time was taken up, the engine being crippled in point of speed. No. 2 and 3 experiments were worked with eccentric gear. Very favourable results have also been obtained from an engine at Wolverhampton, driving a saw-mill. The polish and even wear of the side-plates is quite equal to what was anticipated.

STEAM COMMUNICATION BETWEEN GLASGOW AND NEW YORK—THE "CITY OF GLASGOW" SCREW STEAMER.—Tuesday the 16th of April, 1850, is henceforth a red letter day in the annals of the Clyde, for on that day sailed forth from its bosom, the goodly steam-ship the "City of Glasgow," the first of her class ever sent from this cradle of marine mechanism direct to New York. Her preparation throughout, has been quite a feat in engineering construction, for it was only on the 28th of February that we assisted at the launch of the hull from Messrs. Tod and M'Gregor's yard at the mouth of the Kelvin, and in six weeks she has set out fully equipped for her voyage, after a preliminary short trial trip at sea. Considering the size of the vessel, and the nature of her fittings, this is the most astonishing instance of activity on record. Her chief dimensions are as follow—the new rule of measurement being adopted:—

	Ft.	In.
Length on deck,	227	0
Breadth amidships,	32	7
Depth of hold,	24	7
Length of shaft space,	60	5
Breadth of do.	5	4
Depth,	6	5
Length of engine space,	57	1
Tonnage of do.	499	
" Hull,	1,609	
" Shaft space,	22	
" Registered,	1,087	

She has a pair of beam engines of 350 horse-power, placed side by side, across the keel. The cylinders are 66 inches diameter, with a stroke of 5 feet. The engine beams are each composed of two very deep plates of malleable iron, attached by transverse studs. They are placed above the cylinders as in an ordinary stationary engines, the connecting rods working downwards, and driving wheel and pinion gearing for the screw, which is 13 feet diameter, and 18 feet pitch. The flush spar deck affords a splendid promenade; and the main deck, 237 feet by 34 feet, is well fitted and lighted to serve for recreation in bad weather. The state-rooms are ranged on each side, leaving 16 feet clear between, and a vertical height of 7 feet exists between decks. She is fitted up with 110 berths—52 first class abaft the funnel, and 58 second rate before it; and it is gratifying to find that in this, her first trip, every one has been engaged, by passengers poured in from all quarters of the three kingdoms. In addition to this passenger accommodation, she can take 1,000 tons of goods. Captain Mathews, the well-known officer of the Great Western, has undertaken her command, and in better hands she could not be placed; for in his ninety crossings of the Atlantic, he has won for himself the highest character as a seaman. Her other officials are made up of 20 seamen, 4 engineers, 9 firemen, and 5 apprentices; whilst the wants of the passengers are attended to by 12 stewards, 2 stewardesses, 1 baker, 1 cook, 4 assistants, and a medical adviser. She is barque-rigged, and her preliminary trial showed that she can carry very heavy canvas, and sail fast under it. Two life-boats, two cutters, and two gigs, are provided as precautions for safety; and we are glad to find that the captain has availed himself of some of the ingenious safety contrivances recently patented by R. W. Laurie, Esq., and figured and described in a recent part of this *Journal*. The internal fittings of the ship are by Messrs. M'Murray, Boyd, & Co., of this city. The grand saloon, 54 feet long, is furnished with rich wainscot panelling, the ornamental details being richly carved in the Renaisance style. Mr. Anderson of Paisley has contributed twelve large pictures for the sides, representing a variety of well-chosen scenes. This is certainly a great experiment, and comes fairly within the catalogue of the events of the time, opening up, as it does, a direct communication between our own emporium of manufactures and America's stores of produce. In producing an economical mode of transit, the speculators in the "City of Glasgow" have done more than we could at all reasonably expect. The first-class fare is only twenty guineas, while the second is as low as twelve, and the freights for goods are equally low. We shall watch the progress of the ship with more than ordinary interest,—and for the present, wish her good speed on her maiden voyage.

DEATH OF DR. POTTS.—We have this month to record the death of Dr. Potts, the inventor of the pneumatic pile sinking process, and other valuable plans. Dr. Potts was originally in the medical profession, but his inclinations led him to enter keenly into mechanical pursuits. As a schoolboy, he was a class-fellow of Lord John Russell and the Duke of Bedford, and even at this early age he was noted for his strong bias towards the profession, to which he in later years more fully devoted himself. He will be best remembered for his ingenious plan of sinking hollow iron tubes.

LEAD FOR STATUARY PURPOSES.—An Edinburgh correspondent of the *Athenæum* very justly urges the advantages to be gained by the adoption of lead in statuary work, and instances the equestrian statue of Charles the Second, erected in Parliament Square by the magistrates of the city, in honour of the Restoration, and undoubtedly the finest piece of statuary in Edinburgh, as a fair example of the capabilities of the material. Many who hear of this proposal for the first time, will smile at the idea of applying so soft a material as lead for an office which bronze and granite usually fill, and indeed many even of the Edinburgh residents are ignorant of its successful employment in the work to which we have alluded. That it is really lead, has been ascertained beyond a doubt, as a few years ago the horse's shoulder sank, owing to the failure of one of the iron supports, when the statue was taken down, the sunk parts beaten out, and new supports put in, with a filling-up composition, making it as good as ever. Seeing this is acknowledged to be superior to any of the other bronze or marble statues which adorn the city—and Edinburgh possesses a goodly number, from the hands of the most eminent masters—it must be admitted that the qualifications of lead have been strangely overlooked by the modeller. As regards durability, King Charles has stood 165 years, and yet retains its original excellence.

LECTURE-ROOM MODELS—THE HYDROSTATIC PRESS.—Mr. Burges, of Portugal Street, has just completed, at his brass foundry, two very beautiful models of hydrostatic presses,—one each, for the Glasgow College, and the United College of St. Andrews, Fifeshire. They are intended for philosophical illustrations in the class-rooms, and are fitted up with an especial view to the clear explanation of their details and action. The cylinders are two inches bore, the rams having a stroke of about six inches. The material employed is principally brass, with wrought-iron pillars for the top and bottom of the press. Each model weighs about 220 lbs.

ENGLISH PATENTS.

Sealed from 18th March, to 18th April, 1850.

Robert Milligan, Harden, near Bingley, York, manufacturer,—"An improved mode of treating certain floated warp or weft, or both, for the purpose of producing ornamented fabrics."—March 18th.

George Jenkins, Nassau-street, Soho, Middlesex, gentleman,—"Certain improvements in the means of producing motive power."—18th.

Thomas Edmondson, Salford, Lancaster, printer,—"Improvements in the manufacture of railway and other tickets, and in machinery or apparatus for marking railway and other tickets."—19th.

William Joseph Horsfall, and Thomas James, both of the Mersey Steel and Iron Works, Toxteth Park, Liverpool, Lancaster,—"Improvements in the rolling of iron and other metals."—19th.

Samuel Cunliffe Lister, Manningham, near Bradford, York, and George Edmond Donisthorpe, Leeds, in the same county, manufacturer,—"Improvements in preparing and combing wool and other fibrous materials."—20th.

John Stevenson, Roan Mills, Dungannon, County Tyrone, flax-spinner,—"Certain improvements in machinery for spinning flax and other substances."—23d.

William Sykes, York-street, Middlesex, tallow-chandler,—"Certain improvements in the manufacture of candles and wicks."—23d.

John Varley and Joseph Hacking, Bury, Lancaster, engineers,—"Certain improvements in steam-engines and apparatus connected therewith."—23d.

Henry Robert Ramsbotham, Bradford, York, manufacturer, and William Brown, of the same place, mechanic,—"Improvements in preparing and combing wool."—23d.

William Joseph Curtis, Port of Spain, in the Island of Trinidad, in the West Indies, civil engineer,—"Improved machinery and apparatus adapted for the manufacture of sugar."—23d.

Horatio Carter, Thirza-place, Old Kent-road, Surrey, gentleman,—"Certain improvements in the production of light from ordinary coal gas, by the use of burners consisting of more than one ring or sheet of flame, combined with a suitable chimney or chimneys, and supplied with atmospheric air, particularly adapted to ventilation."—23d.

Joshua Siddeley, junior, brassfounder, Liverpool, Lancaster,—"Certain improvements in ships' fittings."—23d.

Alfred Wilson, Middleton-street, Clerkenwell, Middlesex, clock-case maker,—"Improved ventilator."—23d.

John Gedge, 4 Wellington-street, Strand, Middlesex,—"Improvements in lamps and candlesticks."—(Communication.)—23d.

Nathaniel Matthew, Wern, Tremadoc, Carnarvon, quarry proprietor,—"An apparatus for cutting or dressing slates into various shapes and sizes."—23d.

Alfred Guillaume Roseleur, Paris, France, but now of 4 South-street, Finsbury, Middlesex, chemist,—"Certain improvements in coating or covering metals with tin."—23d.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in the preparation of materials for the production of a composition or compositions applicable to the manufacture of buttons, knife and razor handles, inkstands, door-knobs, and other articles where hardness, strength, and durability are required."—(Communication.)—23d.

Edward Welch, St. John's Wood, London, architect,—"Improvements in fire-places and flues, and in apparatus connected therewith."—23d.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in coupling joints for pipes."—(Communication.)—26th.

Thomas Dickason Rotch, Drumlamford House, Ayr, North Britain, Esq.,—"Improvements in separating various matters usually found combined in certain saccharine, saline, and ligneous substances."—(Communication.)—26th.

Evan Leigh, Miles Platting, near Manchester, cotton-spinner,—"Certain improvements in machinery or apparatus for preparing and spinning cotton and other fibrous substances."—26th.

Joseph Theodore Clenchard, Paris, France, manufacturing chemist,—"Certain improvements in the application of orchill to the processes of dying and printing in colours, and also an improved apparatus to be employed in the operation of dyeing."—26th.

James Precce, Hereford, shoemaker,—"Certain improvements in mills and machinery applicable to the threshing and grinding of corn, the manufacture of cider, and other similar purposes."—26th.

Thomas Walker, Wednesbury, Stafford, ironmaster,—"Improvements in the manufacture of sheets or plates of iron for certain purposes."—28th.

James Samuel, Willoughby House, Middlesex, civil engineer,—"Certain improvements in the construction of railways and steam-engines, and in steam-engine machinery."—April 5th.

Joseph Findlay, Paisley, Renfrew, North Britain, manufacturer,—"An improvement or improvements in machinery or apparatus for turning, cutting, shaping, or reducing wood or other substances."—5th.

George Henry Phipps, Park-road, Stockwell, Surrey, engineer,—"Improvements in propelling vessels."—5th.

Jonathan Charles Goodall, Great College-street, Camden Town, Middlesex, cardmaker,—"Improvements in machinery for cutting paper."—5th.

Charles Seely, Heighington, Lincoln, merchant,—"Improvements in grinding wheat and other grain."—5th.

John Platt, Oldham, Lancaster, engineer,—"Certain improvements in machinery or apparatus for spinning, doubling, and weaving cotton, flax, and other fibrous substances."—11th.

Richard Prosser, Birmingham, civil engineer,—"Certain improvements in machinery and apparatus for manufacturing metal tubes, which improvements in machinery are in part applicable for other purposes where pressure is required; also for improvements in the mode of applying metal tubes in steam boilers, or other vessels requiring metal to be applied within them."—11th.

Amedée Francis Remond, Birmingham,—"Improvements in the manufacture of envelopes."—15th.

Edme Augustin Chameroy, Paris,—"Improvements in the manufacture of boilers and of pipes of malleable substances, as well as of elastic matter."—15th.

Robert Reid, Glasgow, manufacturer,—"Certain improvements in propelling."—15th.

Cuthbert Dinsdale, Newcastle-upon-Tyne, dentist,—"Improvements in the manufacture of artificial palates and gums, and in the mode of setting or fixing natural and artificial teeth."—15th.

John Turner, Birmingham, engineer, and Joseph Hardwick, of the same place,—"A certain improvement or certain improvements in the construction and setting of steam boilers."—15th.

George Attwood, Birmingham, copper roller manufacturer,—"A new or improved method of making tubing of copper or alloys of copper."—15th.

Charles de Bergue, Arthur-street, London, engineer,—"Certain improvements in locomotive and other steam-engines, also in buffers for railway purposes."—15th.

John Dove Harris, Leicester, manufacturer,—"Improvements in the manufacture of looped fabrics."—18th.

William Buckwell, Artificial Granite Works, Battersea, civil engineer, and George Fisher, Taffball Railway, Cardiff, civil engineer,—"Improvements in the construction and means of applying carriage and certain other springs."—18th.

William Henry Ashurst, Old Jewry, gentleman,—"Improvements in the manufacturing of varnishes."—18th.

Thomas Ross, Coleman-street, gentleman,—"Improvements in machinery for raising a pile upon woven and felted fabrics."—18th.

Abraham Moses Marbe, Birmingham, chemist,—"An improved manufacture of vegetable fluid to be used in the production of artificial light, and in lamps or burners for consuming the same; which vegetable fluid is also applicable to the manufacture of lacker or varnish."—18th.

William Hargreaves the younger, Bradford, York, ironfounder,—"Certain improvements in the means of consuming smoke, parts of which improvements are also applicable to the generating of steam."—18th.

SCOTCH PATENTS.

Sealed from 22d March, to 22d April, 1850.

James Higgins, Salford, Lancaster, machine-maker, and Thomas Scholefield, Whitworth, Salford, Lancaster, mechanic, —"Improvements in machinery for preparing, spinning, and doubling cotton, wool, flax, silk, and similar fibrous materials."—March 22d.

François Vouillon, Princes-street, Hanover-square, Middlesex, manufacturer,—"Improvements in the manufacture of hats, caps, bonnets, and other articles made of the same or similar materials."—26th.

William Edward Newton, Office of Patents, 66 Chancery-lane, Middlesex, civil engineer,—"Improvements in the manufacture of knobs for doors, articles of furniture, or other purposes, and in connecting metallic attachments to articles made of glass, or other analogous materials."—(Communication.)—26th.

Jonathan Charles Goodall, Great College-street, Camden-town, Middlesex, cardmaker,—"Improvements in machinery for cutting paper."—27th.

Charles Felton Kirkman, Argyle-street, Middlesex, gentleman,—"Improvements in machinery for spinning or twisting cotton, wool, or other fibrous substances."—28th.

Robert Milligan, Harden, near Bingley, York, manufacturer, —"Improved mode of treating certain floated warp or weft, or both, for the purpose of producing ornamental fabrics."—28th.

Robert White, and James Henderson Grant, both of Dalmarnock-road, Glasgow, North Britain, engineer, —"Certain improvements in machinery or apparatus to be used in mines, which improvements, or parts thereof, are also applicable to other purposes of a similar nature."—April 11th.

William M'Lardy, Manchester, Lancaster, gentleman, —"Certain improvements in machinery or apparatus for preparing and spinning cotton and other fibrous substances."—15th.

John Scoffern, Essex-street, Middlesex, M.B., —"Improvements in the manufacture and refining of sugar, and in the treatment and use of matters obtained in such manufacture, and in the construction of valves used in such and other manufacture."—17th.

James Buck Wilson, St. Helens, Lancaster, ropemaker, —"Improvements in wire ropes."—22d.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 13th March, to 17th April, 1850.

March 13th,	No. 2225.	Thomas Hook, New-cut, Lambeth,—"Portable bed-room fire-escape."
14th,	2226.	William Sellars, Sheffield,—"Saw-back."
March 14th,	2227.	Ritchie and Son, Edinburgh,—"Printing and embossing machine."
—	2228.	Daniel, William, and Thomas Bentley, Margate, Kent,—"Spiral spring compasses."
15th,	2229.	J. and W. Vokins, John's-street, Oxford-street,—"Revolving standard folio frame, for prints, drawings, &c."
18th,	2230.	Haldane and Rae, Edinburgh,—"Part of a tap for drawing off liquids."
—	2231.	Andrew Robertson, Renfrew,—"An apparatus for weighing, measuring, and registering."
19th,	2232.	John Le Blanc, Huddersfield,—"Chest expanding and equalising apparatus."
20th,	2233.	James Wood, Stockport,—"Shuttle-weight, and thread or yarn presser."
21st,	2234.	Alexander Vaughan and John Hossack, Manchester,—"A self-acting lubricator or oil cup for shafts, spindles, or any similar objects revolving in a horizontal position."
—	2235.	Frederick Augustus Dietrich, Bennett-street, Blackfriars,—"An elastic hat lining."
—	2236.	Samuel Collier, Reading,—"Junction pipe or hollow brick."
22d,	2237.	James Lockhead, Frederick Sanders, and Charles Richardson, New Oxford-street,—"A ship's scuttle."
—	2238.	Spilsbury and Downes, Huggin-lane, Cheapside,—"Fastening for articles of dress."
—	2239.	Christopher Haliman, Kensington,—"A fruit protector."
—	2240.	William Wolfe Bonney, Fulham,—"Safety-boat."
27th,	2241.	W. Kidston & Co., Bishopsgate-street,—"Double-action pump."
—	2242.	Alexander Grant and Brothers, Clement's-court, Wood-street, London,—"The 'Fleur de Lis Parasol.'"
30th,	2243.	William Robertson, Glasgow,—"Mineral discharger."
—	2244.	Thomas Dean and Robert Thorburn, Wishaw, Broxburn,—"Drain-tile cutting apparatus."
—	2245.	The Ainslie Brick and Tile Machine Company, Piccadilly,—"Pipe-socket mould, pallet, and cutter."
—	2246.	Frederick Parker, Boston, Lincolnshire,—"Signal apparatus."
—	2247.	William Harding, New Oxford-street,—"The Arden clasp."
April 2d,	2248.	Frederick Wilson, Leeds Rig Foundry,—"Weighting and driving apparatus, to be applied to the rollers of wool washing, calendering, and other machines of similar construction."
—	2249.	Thomas Day and Christopher Martin, Birmingham,—"Rotary heel for boots and shoes."
3d,	2250.	Thomas Waddington, Manchester,—"Paragon neck-tie."
—	2251.	Samuel Last, Oxford-street, and New Bond-street,—"Tient-tout, or railway portmanteau."
—	2252.	Wellington Williams, Gutter-lane,—"Fastening and band for shirt collars."
4th,	2253.	W. H. Martin, Burlington Arcade,—"The pagetina parasol riding-whip."
5th,	2254.	Batters, Clements, and Morton, Saint John's-wharf, Millbank-street,—"Waggon-weighing machine."
—	2255.	Robert Gordon and Co., Heaton Foundry, Stockport,—"Steam-boiler."
8th,	2256.	William Murray, University-street,—"Self-cleansing tubular filter."
—	2257.	John Mather, Beaufort-street, Chelsea,—"Bath valve."
—	2258.	A. Beldham and Co., Portsea,—"Self-supporting waistband."
9th,	2259.	Joseph Welch and John Margetson, Cheapside,—"Clarendon cravat."
10th,	2260.	John Gouger, Wood-street, Cheapside,—"Nonpareil collar."
13th,	2261.	James Seddon and James Eckersley, Little Bolton,—"Cop drier."
—	2262.	John Porter Abbott, Samuel Wright Wade, and Robert Walsbaw, Liverpool, chronometer and watchmakers,—"Dead-beat chronometer."
15th,	2263.	John Hendry and James Murphy, Gifford-street, Kingsland-road,—"Refrigerator."
—	2264.	Louise Smallwood, Dunkerque,—"Improved tile."
16th,	2265.	Scowen and White, 9 Noble-street, Cheapside,—"Aptandum collar."
17th,	2266.	Francis Herbert Wenham, Brixton,—"Parabolic reflector for illuminating transparent objects for a microscope."
—	2267.	George Kelly Matthews, Charing-cross, London,—"Pneumomonitor."
—	2268.	George Frederick Hipkins, Birmingham,—"Nut-cracker."

TO READERS AND CORRESPONDENTS.

T. J., Aberdeen.—He has got into a difficulty very commonly met with by young engineers. The portion which he marks out in red, is not taken into account, simply because it is not a part of the actual diagram. Being outside the path of the tracer, there is no pressure there, and he must take only the number of pounds which the depth of the figure really measures. He would not have a vacuum of 13 lbs. with an unloaded engine, as it would in such case run away. His steam pressure being below the atmosphere, he must allow for this, as so much back pressure. He must go into the subject thoroughly, and, in doing so, he cannot have a better guide than "Main and Brown's Indicator and Dynamometer," or the little practical work which accompanies Mr. M'Naught's Indicators.

T. P., Hants.—Assuming the scheme to be practicable in other respects, how does he make out the mere buoyancy of the goods to be sufficient to carry up their own weight, and that of the waggon, over the apex of each angle, when it is obvious that the water level must be below the very point, *above* which the weight must be lifted to get over? Again, how would he make pig-iron sufficiently buoyant to be capable of transmission in the way he proposes?

E. M., Manchester.—Unless the machine, or the involved principle, was in actual public and well-known use, prior to the date of the patent—the latter is perfectly valid.

R. B., Lincoln.—If we understand his query aright, there is no such relation between the two forces.

G. E. B. B., Kilmarnock.—It is impossible that any contrivance based on the principle he mentions, could in any way mitigate the effect of collisions; unless the paddles could be reversed some time before the moment of collision, it is certain that the danger could not be averted. By the adoption of a buffer arrangement, the concussion might, of course, be softened, but it is too late to talk of reversing the paddles *after* the instant of contact.

J. R.—We are in receipt of his note and printed remarks—too late, however, for Part 26.

Britannia Bridge.—In the "notes" on this structure, at page 14, part 25, for "temper," read "temple."

J. S., Lambeth.—We have never seen any apparatus of the kind applied as he describes, but an invention is now being tried for this and other similar purposes.

A CHAPTER IN THE HISTORY OF RAILWAY LOCOMOTION.

It has been observed by some sapient moralizer, that when a great work is to be done, a man is always found to do it—or rather, he steps forward of his own accord, and undertakes the job. Whilst we are not prepared implicitly to adhere to this wise saw, we cannot well escape its application in railway history, for it must be allowed that when, thirty years ago, the increasing commercial importance of the country demanded a proportionately improved mode of conveyance, which should combine the requisites of economy, speed, and commercial practicability, George Stephenson got up and supplied the deficiency. This he did by an extension of the embryo system then partially in use in his own district of the north of England, for the conveyance of coals to the staiths, or shipping places.

The extent of these colliery lines did not exceed four or five miles, and, looking at the imperfection of the power employed upon them, little could be said as to their chance of superseding horse labour. It cannot, nevertheless, be said, that, even at this early date, the great utility inherent in the system was not tolerably apparent to a few of those early mechanicians whose names have now become interwoven with its fame. Their acute perception enabled them to distinguish, through the then crude and imperfect state of applied mechanics, the immense resources which lay shrouded in futurity, waiting for time and human experience to develop them. The first iron railway ever laid down, to the extent of twenty-five miles, was the Stockton and Darlington line, which was opened on the 27th of September, 1825, the management of the working power, consisting of locomotives, stationary engines, and horses, being intrusted to Mr. Timothy Hackworth, of whose efforts in the introduction of locomotive mechanism we here propose to treat. Twenty miles were worked by locomotives and horses, the two classes of power being placed in competition with each other.* Owing to the inefficient condition of the locomotive power, the Company had all but determined to abandon steam in favour of horses, when Mr. Hackworth proposed to construct an engine suitable for working the traffic on this extent of line. This offer was accepted by the Company, and, by way of economy, it was determined that the boiler of Wilson's engine should be made to serve for the new one. This boiler was a plain cylinder, 13 feet in length, and 4 feet 4 inches in diameter. The heating surface was obtained from a double tube of malleable iron, in the form of the letter U, traversing the whole length of boiler. One side of this tube was made available for the fire-grate; and the heated vapour being passed through it, was returned by the opposite one to the chimney, which was actually a vertical continuation of this end. With this contrivance the engine had a heating surface double that of any other engine of its time. She was carried on six 4-feet wheels, four of them being spring-mounted, and was the earliest of the six-wheel coupled class. The cylinders, 11 inches in diameter, and 20 inches stroke, were placed vertically at what is now the smoke-box end of the engine, and worked directly upon the first pair of wheels. At the same end was attached a malleable-iron cistern, into which the water passed from the tank, previous to being introduced into the boiler, the driver having the power of regulating the supply; and a pipe from the steam exhaust was led into the cistern, for the purpose of admitting steam at pleasure, to heat the water. Another pipe was provided for the purpose of leading off a steam jet from the exhaust-pipe at the chimney end, for discharge beneath the grate, the intention being to facilitate combustion.

In addition to its being the original of a class of engines now so universal, this engine was the first which had a blast-pipe fitted to it, the whole of the exhaust steam—excepting only such a portion as was required for the purposes before alluded to—being conveyed into the centre of the chimney, and there thrown out in a jet from a conical pipe. She was named the "Royal George," and commenced working in October, 1827.

As an exposition of her superiority over the horses—which, be it remembered, were at this time in the ascendant, as regards their employment on railways—we may compare the actual results of the two systems of working.

Cost of "Royal George," £425; number of tons conveyed by her in one year (1828), 22,442 tons over twenty miles; cost of conveyance, ¼d. per ton per mile, or, including all repairs and maintenance, and interest on sunk capital, at 10 per cent., £466; an economy in working which is rarely exceeded at the present day, after a lapse of twenty-three years. The cost of the same work performed by horses was £998, showing a difference of £532 in favour of this engine, over the animal power.

The points of improvement in the "Royal George" which conduced to this important result, evidencing not only her great superiority over her compeers, but the vast resources of the imperfectly developed locomotive system, were simply these:—the increased evaporative surface of the boiler; the perfect command over heavy loads in all states of the weather, by reason of the superior tractive adhesion derived from the six coupled wheels; and the introduction of the blast-pipe, an invention which alone will carry down the name of Hackworth to future ages in connection with early locomotive history.

Up to the period of which we write, no really efficient locomotive was in use, as the steam pressure invariably fell, in spite of the best efforts of the driver; and the superiority of the "Royal George," in this respect alone, at once elevated it far above its contemporaries, for it was capable of maintaining a speed of nine miles per hour throughout its run of twenty miles, in all weathers.

Amongst all the details of the locomotive, perhaps no one point has afforded so much material for speculative invention as the exhaust draught apparatus, and yet, out of the accumulation of schemes for this purpose, which have taken every devisable shape, as fanners and bellows, nothing has arisen to supersede the original blast-pipe in the smallest degree. After twenty years' experience, nothing more has been elucidated than the simple fact, that to get it as wide as possible is the ultimatum of perfection. In naming the novelties brought out in the "Royal George," we must not forget to add, that she possessed the first short-stroked force-pump, as also the first set of adjustable springs for the safety-valves, instead of weights.

To illustrate the state of popular feeling prevalent at this time in reference to the contest between locomotives and horses on the Stockton and Darlington line, we extract a few passages from a letter addressed by Mr. Robert Stephenson to Mr. Hackworth, dated Liverpool, July 7, 1828:—

"The directors having heard here, by some channel or other, not favourable to the locomotive engines, that there has always been a great number of horses on the line, and that the horses were beating the engines off,—in answer to this I understood you to say, that at one time you had completely run the horses off, but in consequence of the late accident, and the heavy engine being laid aside, you had been obliged to employ horses again. Was not this the sole cause of the horses being employed? and was there not an instance, a little while ago, of the horses being entirely removed from the line of road? Please write me by return of post, or, at all events, at your earliest convenience, answers to these queries. I cannot wonder at the travelling engines having so much to contend, when I come in contact with enemies to them every hour; and they prove to be enemies without reason, they oppose the engines merely because certain things have been said against them."

The accident alluded to in this extract was the explosion of one of the engines, supposed to have been caused by a driver having neglected to remove a spring which was employed to steady the weight upon the safety-valve lever during running, this removal being necessary when-

* There were, at this time, five locomotives on the line: four built by Messrs. Stephenson & Co., of Forth-street, Newcastle, and one by Mr. Wilson, of the same place.

ever the engine stopped. The "heavy engine" was the "Royal George," then undergoing repairs; hence the want of the two engines involved the necessity of employing horses until the repairs were effected. In a letter written by Mr. G. Stephenson, dated Liverpool, July 25, 1828, the following occurs:—

"Brandreth has given a report here that you are going to lay off the locomotive engines. Is it so? It was a great pity that the accident took place with the tubes. We have tried the new locomotive engine at Bolton; we have also tried the blast to it for burning coke, and I believe it will answer. There are two bellows, worked by two eccentries underneath the tender."

In the early part of the year 1829, as the Liverpool and Manchester line approached completion, the directors laid their heads together to determine on what kind of power they were to use. They had, in the previous year, formed a deputation from amongst themselves, to visit the different lines in the north of England, the counties of Northumberland and Durham being the only districts where the different systems of power were practised to any appreciable extent. It would appear, that, notwithstanding the inspection by the deputation, they were yet unable to decide; and the only conclusion at which they arrived was, that owing to the great traffic anticipated on the new line, it would be impossible to work it by horses. This confined the question within narrower limits, locomotive and stationary engine power being the only systems available for choice.

To set the question at rest, two practical engineers were appointed to visit the Stockton and Darlington and Newcastle lines, and to report thereon. The engineers chosen were Mr. Rastrick of Stourbridge, and Mr. Walker of Limehouse, who accordingly made a joint report on the subject, in March, 1829.

After the conclusion of their investigations, and previous to the issue of their report, these gentlemen made application to Mr. Hackworth for particulars of the expenses connected with the maintenance of the locomotive engines on the Darlington line, and when the report appeared, it contained their well-known decision in favour of stationary power.

Mr. Robert Stephenson was at this time carefully searching for evidence to support him in his opinion in favour of the locomotive system, in opposition to the report. A letter from him to Mr. Hackworth, dated March 17, 1829, refers particularly to this question:—

"The reports of the engineers who visited the north, to ascertain the relative merits of the two systems of steam machinery now employed on railways, have come to conclusions in favour of stationary engines. They have increased the performance of fixed engines beyond what practice will bear out, and, I regret to say, they have depreciated the locomotive engines below what experience has taught us. I will not say whether these results have arisen from prejudice, or want of information or practice on the subject. This is not a point which I will presume to discuss. I write now to obtain answers to some questions on which I think they have not given full information. Some of their calculations are also at variance with experiments that have come under your daily observation. For instance, they state it positively as their opinion, that a locomotive engine of 10 horse power, or say, of the usual size, will not convey more than 10 tons, exclusive of the wagons, at the rate of 10 miles per hour in winter-time, and in summer the same engine will take 13½ tons. The calculation is made on the assumption of the road being level. In answer to this statement, will you be kind enough to state at what speed your own engine returns from Stockton with a given number of empty wagons, and the rates of ascent? The whole ascent will do, to get an average. State also at what speed the six-wheeled engine made by R. S. & Co. will return with any given number of wagons. What load, including wagons, will an engine, weighing 9 tons, including water, take at the rate of 10 miles an hour on a level well-conditioned railway? Let it be understood that all your statements are made under the supposition that the speed is to be maintained for 20 or 30 miles without stopping, except for water. Let me have your general opinion as to the locomotive engine system. Is it as convenient as any other? Would you consider 13½ tons in summer, and 10 tons in winter, a fair performance for a good locomotive engine? You will oblige me much by answering the above questions as promptly as possible, as the discussion on the merits of the two systems is yet going on amongst the directors here."

The reply to the above letter, in answer to the several questions propounded, was the following:—

"The statement you allude to, that a complete locomotive will take but 10 tons at 10 miles per hour, is quite at variance with facts: as an opinion merely, this I would forgive. Four of our wagons, laden for depots, frequently take from 12 to 13 tons of coals, exclusive of the wagons. Our engines never take less than 16 laden wagons in winter, and in summer from 20 to 24 and 32 laden, and can maintain a speed of 5 miles per hour, except in case of stoppages by means of horse wagons at the passing places. Engines thus loaded have frequently travelled at 9 miles per hour, sometimes more. It is unsafe to aim at speed upon a single line of railway, the danger is at the passing places. I am verily convinced that a swift engine, upon a well-conditioned railway, will combine profit and simplicity, and will afford such facility as has not hitherto been known.

"I am well satisfied that an engine of the weight you mention, will convey, on a level, in winter, 30 tons of goods, 10 miles per hour, exclusive of carriages, and 40 tons in summer, exclusive of carriages. The six-wheeled engine fitted up at the Company's works, generally takes 24 wagons, 53 cwt. to 3 tons of coals each, speed 5 miles per hour, empty wagons 24 cwt. each. The six wheels by R. Stephenson and Co., —20 wagons, 5 miles per hour, weight as above.

"As to my general opinion as to the locomotive system, I believe it is comparatively in a state of infancy. Swift engines upon a double way, I am convinced, may be used to the utmost advantage. Improvements upon anything yet produced, of greater importance in all respects, are clearly practicable; and I am sure this will prove itself by actual remuneration to such parties as prudently, yet diligently, pursue the execution of this kind of power, with their eyes open to those alterations and advantages which actual demonstration of local circumstances point out.

"Stationary engines are by no means adapted to a public line of railway. I take here no account of a great waste of capital. But you will fail in proving to the satisfaction of any one, not conversant with these subjects, the inexpedieney of such a system. It never can do for coaching; passengers cannot be accommodated. If endless ropes are used, there will be both danger and delay. What provision can be made to answer the stretching of ropes? I have known a rope a mile and a quarter long, stretch 70 fathoms in one day. What set of apparatus will be found practically applicable to give the rope proper tension? Admit it to be possible, who would dare to be near when a mass of matter standing at rest, say 20 to 30 tons, is first put in motion by a rope, moving at the rate of 10 to 15 miles per hour? It need not be added what will follow—a scene of endless confusion!

"I hear the Liverpool Company have concluded to use fixed engines. Some will look on with surprise; but as you can well afford it, it is all for the good of the science and of the trade to try both plans. Do not discompose yourself, my dear Sir; if you express your manly, firm, decided opinion, you have done your part as their adviser. And if it happen to be read some day in the newspapers—'Whereas the Liverpool and Manchester Railway has been strangled by ropes,' we shall not accuse you of guilt in being accessary either before or after the fact."

There was still considerable indecision in the matter on the part of the directors, although considerable partiality was evinced by the major portion of them in favour of the locomotive, provided engines of this class could be built of sufficient power, whilst their weight was kept below

that of the existing engines, some seven or eight tons; and in conformation with the railway act, requiring that no smoke should be discharged.

To distinguish accurately what was the cause of this favourable leaning of the directors towards the locomotive system, after the very opposite evidence which they had received, may, perhaps, be deemed a straining of the point; but there is good room for the presumption, that the evidence supplied by Mr. Hackworth, through Mr. Robert Stephenson, in the letter which we have quoted, had considerable influence in determining their choice. No other person had at this period anything like the practical knowledge which he possessed, in reference to the working of railways by both systems, the relative merits of which he had fully tested on the Darlington line.

One of the directors—Mr. Harrison—having given it as his opinion, that the expectancy of a reward, to be offered to the public as an excitement to competition, would have the desired effect,—this mode of procedure was at length adopted; and, in April, 1829, they offered a premium of £500 for the best locomotive engine, conformable with certain regulations and conditions. The story of the competition—in which Mr. Hackworth joined—with the results of the test of the different engines, has been often told.

It is to be regretted that Mr. Hackworth, as an agent of the Stockton and Darlington Company, had not more extended means for the more perfect accomplishment of his designs; and that only such time as could be snatched from their service, could be devoted to his own plans. As the Company's means were little more than adequate to the repairs of their own plant of engines, a great part of the work in his trial engine was executed at other establishments—the boiler being made at the Bedlington Iron Works, and the cylinders by Messrs. Stephenson.

The "Sanspareil" had a cylindrical boiler, 6 feet long, and 4 feet 2 inches diameter, one end being flat, and the other hemispherical. The heating surface consisted of a double tube traversing the whole length of the boiler, and returning to the fire-end; the fire-grate and chimney being both at one end of the engine—the fire-grate in one tube, whilst the chimney terminated the other. The tube extended from the boiler to a length of about 3 feet, with a casing of a semicircular form surrounding it at the fire-end, except at the chimney, where this casing extended only 2 feet. With this arrangement, a greater extent of heating surface was obtained, than if tubes limited to the boiler's length had been used. The length of the grate-bars was 5 feet, and the diameter of the tube at the fire-end 2 feet, reduced to 15 inches in the return tube, this being also the size of the chimney. The area of the fire-grate was 10 square feet; the area of the surface of water exposed to the radiating heat, or direct action of the fire, being 15.7 square feet; and that acted on by the carried heat, 74½ square feet. She was carried on four wheels, 4 feet 6 inches diameter. The boiler was very imperfect as a piece of workmanship, and considerable leakage resulted. To such an extent were the joints defective, that many of them had copper run in and caulked up to make them steam-tight. Of the cylinders the same may be said—six castings were made before two perfect ones were got. The sixth cylinder had to be substituted at Liverpool, immediately after the contest at Rainhill, the fifth having burst during the competition. The imperfection in this case, was in the metal forming the partition between the bore of the cylinder, and the port-way or steam-pipe along the cylinder side, which had been cast and bored so thin in one part, as to leave less than $\frac{1}{10}$ inch of metal. The consequence was, that the engine had no sooner commenced working than the cylinder burst, when the race had to be run with one perfect cylinder only, whilst the fracture of the other one opened at every stroke a direct communication between the boiler and the chimney. Not only did this mal-adventure render the "Sanspareil's" case hopeless, by a tremendous loss of steam, but as each burst took place when the steam-slide opened the communication with the injured cylinder, a great quantity of fuel was ejected from the fire-grate. It is obvious that, under these circumstances, the "Sanspareil" had little chance against the "Rocket"—Messrs. Stephenson's engine—which was perfect in all its constructive details. As it was, the only superiority of the latter was in her economy of fuel. The trial run, indeed, was not of such a character as fairly to test the two engines—the distance being no more than 1½ mile. The blast-pipe of the "Sanspareil" was fitted to enable her to maintain her working pressure during a long journey; whilst the "Rocket," unprovided with this appendage, was capable of generating steam nearly as well when at rest as when in action. Thus the latter was enabled to get up a sufficiency of steam for her run, previous to starting, and when brought to a stand at the stations, regained the steam-power lost during the run, which was well performed on so short a distance as 1½ mile. This would not have been the case in the regular journeys of a working line. Such a test, therefore, was practically worthless, in arriving at a due comparison of performance for a line of considerable length, like the Liverpool and Manchester.

Shortly after this trial, Mr. Stephenson being anxious to investigate the "Sanspareil's" blast-pipe, despatched a nocturnal visitant to inspect it, and take its dimensions. Our informant on this little bit of finesse, is the actual person who made the survey—he is still living. The result of the observations which he made was, that a similar blast-pipe was constructed and fitted to the "Rocket." The actual working efficiency of the "Sanspareil" has been tolerably illustrated in Mr. Armstrong's work on Steam-Boilers, where he says that—"The original 'Sanspareil' of Mr. Hackworth, which all but successfully competed for the prize at the opening of the Liverpool and Manchester Railway, may still be seen regularly working on the Bolton and Leigh Railway, apparently not much worse for seven years' constant work, the boiler never having required any essential repair,* while its contemporary rivals, that have escaped the fate of the 'scrap heap,' have been re-made, and mended over and over again, since the celebrated race at Rainhill, a fact which goes far to prove that the principle of this engine has not been so very much improved upon, except that it is not so well calculated for burning coke as coal. The 'Sanspareil' may frequently be seen at the Kenyon Junction, waiting for the Bolton trains from Liverpool, and plans of it may be seen in Dr. Lardner's work."

In one point the "Rocket" possessed a feature of eminent superiority, which has since proved to be the main-stay of the modern locomotive—in the small flue-tubes—the invention of Mr. Henry Booth, the talented secretary of the Liverpool and Manchester line, to whom railways owe much of their present practical efficiency.

The extreme lightness of the engines insisted on by the directors, led to an objection against the "Sanspareil," on the ground of an excess of weight; but it was forgotten, that although in gross weight she exceeded her rival, yet on neither pair of wheels was there so great a pressure as in the latter. At this time, when each engineer was feeling his way, some curious specimens of locomotive mechanism were turned out. A letter written to Mr. Hackworth, by one of the directors of the Stockton and Darlington line, gives a facetious account of an engine supplied to that line by Messrs. Stephenson:—"I should have been extremely glad to have heard that fair play had been allowed to the different engine-makers who were competitors for the premium; from the very cool reception that a *Timothy* received from Forth Street, George showed very plainly that he was much afraid of the Shildon production; and well they might, as they well know that every engine which they have yet sent, has had great need of mending. The new one last sent was at work scarcely a week before it was completely condemned, and not fit to be used in its present state. The hand-gear and valves have no control in working it. When standing without the wagons at Tully's a few days ago, it started by itself when the steam was shut off, and all that Jem Stephenson† could do he could not stop it,—it ran down the

* Since it was properly repaired immediately after the contest at Liverpool.—Ed. P. M. Journal.

† Brother to the late Mr. George Stephenson.

branch with such speed, that old Jem was crying out for help, every one expecting to see them dashed to atoms; the depots being quite clear of wagons, this would have been the case, had not the teamers and others thrown blocks in the way, and fortunately threw it off.

"A similar occurrence took place on the following day, in going down to Stockton. As soon as the wagons were unhooked at the top of the run, away goes *Maniac!* defying all the power and skill of her jockey, old Jem, nor could it be stopped until it arrived near the staiths. Had a coach been on the road coming up, its passengers would have been in a most dangerous position. The force-pump is nearly useless, having had, every day it was at work, to fill the boiler with pails at each of the watering places. No fewer than three times the lead plug has melted out. This *Maniac* was a Forth Street production, and at last was obliged to be towed up to the *hospital* by a real Timothy * in front, on six wheels, and actually had twenty-four wagons in the rear as guard. It is now at head-quarters at Shildon.

"From what I have heard of the doings with you, it appears that the engine which had *a Booth* as the inventor of the copper pipes in the boiler, was, without either judge or jury, to be the winner."

On Mr. Hackworth's return from Liverpool, he found the "Rocket" lodged in the shed, waiting his arrival; and, as the Company's engineer, he had to put her in the best possible repair. From the defective construction of the hand-gear, and the imperfection of her force-pump, these details had to be completely remodelled.

The next engine which figured conspicuously on the Stockton and Darlington line was the "Globe," which was the first ever designed with a crank-axle. She was built from Mr. Hackworth's designs, by Messrs. Stephenson, as the Railway Company's hands were too full to allow of the work being done at their private establishment. The novelties carried out in her were—the crank-axle working by inside cylinders beneath the boiler, and a modification of the hand-gear, whereby the reversing was effected by a single lever—two drivers being placed on the axle, one on each side of the pair of eccentric sheaves. The wheels were four in number, 5 feet diameter, being the largest then in use. A single flue ran straight through the boiler, having the fire-grate in one end. A number of small tubes were also passed transversely through the diameter of the main flue, so as to form a species of spiral, the water being allowed to circulate through them. This arrangement effectively exposed a considerable surface to the action of the heat; and her steam-generating powers were much superior to any other engine of her time, having the same area of heating surface. Still, at this date, a great objection existed in the slow circulation of the water through the tubes, and the consequent accumulation of mud in the horizontal tubes, which, forming an incrustation, speedily destroyed them. Another novelty in her construction, was the placing a copper globe on the top of the boiler, to serve as a steam-receiving dome—hence arose her name. This engine opened the branch line between Stockton and Middleshro', a distance of four miles. Her rate was frequently fifty miles per hour.

All constructive innovations are invariably looked upon with distrust by the merely practical man; and when the designs for this first crank-axle engine were laid before Messrs. Stephenson for their execution, an objection was raised by one of the officials of the establishment, that the crank-axle would certainly involve a loss of power, as the efficient length of lever could only be calculated from the inside of the journal to the axle's centre.

In 1830, the increase of traffic on the Stockton and Darlington line, requiring an addition to the working stock of engines, two different modifications were designed by Mr. Hackworth. Both these were six wheelers, spring-mounted, and coupled throughout; the boiler of the first kind being 13 feet long. The flue consisted of a main tube, 9 feet long, by 2 feet 6 inches diameter, in one end of which the fire-grates were inserted. The other end was separated from the boiler by a partition-plate, into which a number of small copper tubes, 4 feet in length, were inserted, for the conveyance of the vapour through the remaining portion of the boiler to the smoke-box, which was at the contrary end to the fire. The cylinders were placed vertically at one end of the boiler, their connecting rods being attached to a crank-shaft directly beneath. This was a plain shaft, with two cranks keyed on its ends at right angles to each other. From these cranks, coupling rods passed to similar cranks on the axles of the whole set of wheels. The slide-valves were actuated by two eccentries, having a single lever reversing apparatus; the force-pumps being worked by the same eccentries.

In the second arrangement, the distinctive feature was in the heating surface—the valve-gearing, cylinders, wheels, and connections being as before, except that the cylinders were mounted on framing projecting six feet from the boiler. The boiler was 10 feet long, by 4 feet 4 inches diameter, and the arrangement of heating surface presented some novelties now much in use in the northern English counties, and termed a "return multitubular fire-tube." It consisted of a main tube, 2 feet 4 inches diameter at the large end, reduced to 2 feet at the opposite end, and 8 feet long. The large end contained the fire-grates, and at the small end, a box of a D shape was placed to receive the heated vapour after its passage through the main tube, conveying it back again through the water by a number of small copper tubes, surrounding the large tube on all sides except the bottom, being inserted in the tube-box at one end, and in the plate forming the end of the boiler at the other. At the fire-end, a semicircular box carried the smoke into the chimney. This arrangement proved to be the best of its day for the general traffic of the line, as well in its economy as in its durability, the flues having been repeatedly known to wear for six years without removal. It also afforded the means of a convenient removal of the heating surface, so that in an engine provided with a duplicate heating surface, the old one could be removed and a new one added, ready for work within three days. It is said that these engines have performed a greater amount of duty than any others extant.

We have now glanced at the various gradations of improvement in the early stages of locomotive building, which it is impossible to contemplate without paying a deserved tribute to the great ability displayed in this branch by Mr. Hackworth, at a time when everything had to be learned —when, indeed, engineers were utterly thrown upon their own resources. No later than 1846, one of the agents of the Stockton and Darlington Company stated, in reference to the last class of engine we have described, that, "take them weight for weight, they surpass any engine on the line."

If George Stephenson deserved the title of the "Father of Railways," we think we may at least claim for Timothy Hackworth that of the "Father of Locomotives."

* Royal George Engine.

A SCHEME OF A RATIONAL CLASSIFICATION FOR THE SCIENCES.†

I.

It is not my intention to criticise, unfortunately a work of little difficulty, the numerous classifications of the different branches of exact knowledge, which have been proposed during the last two centuries. Every one is convinced, that all the encyclopædic arrangements, constructed, like those of Bacon and d'Alembert, with reference to our different faculties, are, for that reason alone, radically erroneous, even when the difference is not, as often happens, more ingenious than real, since, in every one of its actions, our understanding simultaneously employs all its principal faculties. As to the other proposed classifications, it is sufficient to observe that, in the discussions which they have provoked, it has been elicited that they are all open to fundamental objections, so that not one

†These observations have been translated from Auguste Comte's *Cours de Philosophie Positive*, a very valuable French work on the philosophy of the sciences. G. H. Lewes, in his Biographical History of Philosophy, terms Comte the Bacon of the nineteenth century; and John Stuart Mill, in his work on Logic, pays him some very high compliments.

has obtained unanimous assent; and, indeed, there exists, in this respect, almost as many opinions as individuals. Most of these attempts have been so ill executed, that a strong prejudice exists amougst many persons against every project of a similar kind.

We need not enlarge upon a well-known fact, but it is of some importance to inquire the reason of it. Now, it is easy to expose the great imperfection of these attempts. Since the general discredit into which such schemes have fallen, they have been chiefly undertaken only by persons who are entire strangers to the objects to he classed. Passing by this consideration, which refers only to persons, there is another, much more important, flowing from the very nature of the subject, which clearly shows why it has not been previously possible to plan a really satisfactory scheme. It consists in the want of homogeneity which has hitherto reigned between the different branches of scientific knowledge —some becoming gradually positive, whilst others remained in their supernatural or metaphysical stages.* When matters were thus marked by incongruity, it was quite impossible to establish any rational classification, for bow could conceptions so contradictory he disposed in a consistent plan? All the classifiers foundered upon this difficulty without having perceived where it lay. Nevertheless, it was apparent to those who were acquainted with the real situatiou of the human mind, tbat such a scheme was premature, and that it could not be successfully undertaken until all our principal conceptions had become positive. As this fundamental condition may now be regarded as realised, we are able to undertake an arrangement really rational and permanent, of which all the parts have at length become homogeneous.

On the other hand, the general theory of classifications estahlished of late by the philosophic labours of botanists and zoologists, affords us hopes of success in a similar performance, by offering a certain guide in the true fundamental principle of the art of arrangement, a principle which had never previously been distinctly perceived. This principle is a necessary consequence of the application of the positive method to the subject of classification, which, like every other subject, ought to he deduced from observation of facts, and not resolved by *à priori* considerations. It consists in founding the classification upon a study of the objects to be classed—that is, upon their real affinities and natural connections, so that the very classification should be an expression of the highest generalization obtained by a philosophic comparison of the objects which it embraces.

Applying this fundamental rule to actual circumstances, the mutual dependence really existing amongst the positive sciences must guide us in classifying them; and tbis dependence can only result from a corresponding dependence of tbe phenomena. But, before entering upon such an important encyclopædic labour, it will be desirable to circumscribe, with more precision than we have hitherto done, the peculiar subjects of the proposed classification, in order that we may not involve ourselves in too extensive an undertaking.

All human labours are conversant with either speculation or action. Hence, the most general division of our real knowledge is that which separates it into theoretical and practical. It is, however, solely to the former that I shall direct attention in this work, since my design is not to take a survey of the whole range of human ideas, but only of those fundamental conceptions with respect to the various classes of phenomena which furnish a solid basis for all other combinations whatsoever, and which are not in their turn founded upon any preceding intellectual system. Therefore, in a work of this kind, it is speculation we must consider, and not its application. No doubt, when we survey the whole circle of human labours, we ought to consider the study of nature as destined to furnish the true rational basis of the operation of man upon nature, since the knowledge of the laws of phenomena, the constant result of which is to lead us to their prediction, can alone conduct us in practice, to modify some of them, by means of others, for the benefit of man. Our natural aud direct means for operating upon the bodies which surround us are extremely feeble, and altogether disproportionate to our wants. Whenever we succeed in doing anything on a grand scale, it is only because a knowledge of natural laws teaches us how to introduce, amongst the circumstances determining the several phenomena, some modifying elements which, however feeble in themselves, are sufficient to bring about the results that we desire. In some, from science proceeds prevision, and from prevision, action: such is the formula which expresses with accuracy the general relation of *science* and *art*, using these words in their widest acceptation.

But, in spite of the capital importance of this relation, which ought never to be forgotten, we should form a very imperfect notion of the sciences if we were to consider them merely as the bases of arts, a notion, however, to which, unfortunately, we are now-a-days but too much inclined. Whatever may have been the immense services rendered to industrial labours by scientific theories,—although, to use the energetic expression of Baeon, "Knowledge is Power"—(that is, power is necessarily proportioned to knowledge),—we should not forget that the sciences have a more direct and elevated destiny—that of satisfying the fundamental desire of our intellect to know the laws of phenomena. To feel how profound and imperious is this desire, it is sufficient to refleet an instant on the physiologieal effects of *terror*, and to consider that the most fearful sensation which we can experience, is that produced whenever any phenomenon seems to contradiet those laws of nature with which we are familiar. The desire of placing facts under an arrangement which we can easily understand—and this is the proper object of all scientific theories—is so inherent in our organization, that if we did not succeed in satisfying it by positive conceptions, we should inevitably return to supernatural and metaphysical explanations.

I have thought myself bound, at the present moment, expressly to warn my readers against the too great influence of the habits of active life,—habits which tend to hinder the formation of just and noble ideas as to the importance and destiny of the sciences. If the preponderating authority of our organization did not correct, it may he involuntarily, in the minds of scientific men, that which, in this respect, is incomplete and illiberal in the general tendency of our age, the iutellect of man, being occupied only in researches capable of yielding an immediately practical and useful result, would, as Condorcet has justly remarked, be entirely arrested in its progress, even in regard to those pursuits, for the sake of which it had imprudently sacrificed pursuits purely speculative; for applications of the utmost importance are constantly flowing from theories framed in the prosecution of some branch of science for its own sake, a branch which, probahly, has been cultivated for centuries without resulting in anything practical. I may cite, as a remarkable example, the speculations of the Greek geometers on conic sections, which, after a long series of generations, have served to carry the art of navigation to its present state of perfection,—a state to which it never would have arrived had it not been for the purely theoretical labours of Archimedes and Appollonius,—so that Condorcet might well say, that the sailor who is preserved from shipwreck by an accurate observation of the longitude, owes his life to a theory conceived two thousand years ago by men of genius, who had in view nothing more than simple geometrical speculations.

It is, therefore, evident that, after having conceived, in a general manner, the study of nature, as serving for a rational hasis for man's operations upon nature, the human mind should proceed to theoretical researches, and entirely put out of view every practical consideration; for our means of discovering truth are so feeble, that, if we do not concentrate all our efforts upon this object exclusively, but encumber ourselves, at the same time, with a searcb after some immediately practical and useful result, it would be almost always impossible to arrive at the end in view.

At the present state of advancement of human knowledge, the sciences are not directly applied to the arts, at least in the most perfect instances. There exists between these two orders of ideas a middle order, which, though still imperfectly determined in its philosophic character, becomes better defined to our view when we look at the class in society which is specially engaged upon it. Between scientific men and the actual directors of productive labours, an intermediate class has begun in our days to he formed—that of *engineers*—whose special business it is to organize the relations of theory and practice. These persons have not at all in view the progress of scientific knowledge. They make use of science in its actual state of development, in order to apply it to the furtherance and assistance of labour. Such, at least, is the natural tendency of tbings, although there is still much confusion in these matters. The ideas proper to this class, and which ought to embody true theories of the different arts, would, without doubt, afford occasion for philosophic considerations of great interest and importance; but to treat these considerations conjointly with those founded upon the sciences, properly so called, would he at present quite premature, for the ideas arising out of

* In studying the development of human intelligence, I believe that I have discovered a grand fundamental law to which it is subjected by necessity—a law whereby each of our leading conceptions, and every branch of knowledge, pass successively through three different theoretical states—namely, the supernatural, or fictitious; the metaphysical, or abstract; and the scientific, or positive state. In other words, the mind successively employs, in its inquiries, three methods of philosophising, the character of each being essentially different from, and radically opposed to, that of the others. In the first, the mind seeks after the essences of things, their first and final causes—in a word, after absolute knowledge. All phenomena are regarded as the work of supernatural agents, by whose arbitrary intervention all the apparent anomalies in the on-going of the universe may be explained. The metaphysical state is but a modification of the preceding. It serves, however, as a means of transition from the supernatural to the positive state. Supernatural agents give place to abstract forces, veritable entities inherent in the various things composing the world, and capable of causing all observed facts. In the positive state, the mind acknowledges the impossibility of obtaining absolute notions, and gives up its research after essences and final causes, in order to seek for effective laws —that is, the invariable relations of succession and similitude. Phenomena are then explained by the connection which is seen to be established between individual and general facts, and these latter, as science advances, become more and more lessened in number.

the application of pure theory to practice have not yet been formed into a systematic body of doctrine. At present there exists nothing beyond some imperfect elements relating to the most advanced sciences and arts, allowing us only to contemplate at a distance the nature and possibility of similar labours for the whole circle of human operations.

We shall the more easily understand the difficulty of constructing these intermediate doctrines, if we consider that each art depends not only upon some one corresponding science, but upon several, so that the most important arts derive assistance from almost all the principal sciences. It is thus that the true theory of agriculture, to limit myself to the most important case, requires a combination of physiological, chemical, physical, and even astronomical and mathematical knowledge. And so in the fine arts. Hence it is easy to see why the theories alluded to have not yet been formed, since they require the previous development of all the different fundamental sciences.

Two classes of natural science are to be distinguished with respect to phenomena of every kind. Those which are abstract and general, have for their object the discovery of the laws governing the different classes of phenomena upon a consideration of every possible case. Those which are concrete, particular, descriptive, and which are sometimes designated as the physical sciences, properly so called, consist in the application of these laws to the history of the various bodies in existence. The first are, therefore, fundamental; the others only secondary. This distinction will present no difficulty to those who are at all acquainted with the different sciences, since it is nearly equivalent to that commonly noticed in most of the scientific treatises, on comparing dogmatic physics with natural history. A few instances will render this division clearer, the importance of it not being yet properly appreciated. Compare general physiology on the one hand, with zoology and botany on the other, and the distinction will be evident. To study the general laws of life, and to determine the mode of existence of each living body, are manifestly very distinct employments. Moreover, the latter is necessarily based upon the former. And so with chemistry in regard to mineralogy,—the first is evidently the true basis of the second. In chemistry, all the possible combinations of molecules, under every imaginable circumstance, are considered. In mineralogy, we only consider such combinations as are actually found on the globe. That which strikingly exhibits the difference between the mineralogical and the chemical point of view, is, that although they may have reference to the same class of objects, the facts taken into consideration by the first, have, for the most part, only an artificial origin and existence, so that a body, such as chlorine or potassium, may hold a very important rank in chemistry by the multiplicity and energy of its affinities, whilst it takes an insignificant place in mineralogy. On the other hand, a mineral composition, like granite or quartz, may occupy much attention in a mineralogical point of view, whilst, with respect to chemical science, it has quite a subordinate interest.

The logical necessity of this fundamental distinction between the two grand sections of natural philosophy is very apparent, when we consider that not only does each section of concrete physics suppose the previous culture of the corresponding section of abstract physics, but that it also requires an acquaintance with the general laws relating to all classes of phenomena;—thus, for instance, the study of the globe, in all its various relations, not only requires a previous acquaintance with physics and chemistry, but it cannot be properly undertaken without assistance from astronomy on the one hand, and from physiology on the other, so that it is connected with the entire system of the fundamental sciences,—and the same thing occurs in each of the other natural sciences. It is precisely on this ground that concrete physics has made so little real progress up to the present time, since it was not possible to study it in a manner truly philosophical until after abstract physics had been so studied, and when all the different branches of the latter had found their appropriate places, which has not been the case until our own day. Materials more or less incoherent, and which even yet are very incomplete, were all that it was possible to collect. Known facts cannot be arranged so as to form true special theories touching the different bodies of the universe, until the fundamental distinction here enforced shall be more profoundly perceived and more completely organized, and, consequently, until the philosophers, specially employed in studying the natural sciences, shall have recognized the necessity of basing their researches upon a thorough knowledge of all the fundamental sciences, a condition even yet far from being realised.

The chief object to be kept in view in every encyclopædic arrangement, is to place the sciences in the order of their natural connection, by tracing their mutual dependence, so that they can be successively treated without our being ever entangled in a vicious circle. Now this appears to me a condition impossible to be altogether complied with, and I will proceed to explain the reason. All the sciences may be treated after two essentially distinct methods, of which every other mode of treatment will only be a combination: the *historical method*, and the *dogmatic method*. By the first, we treat the different branches of knowledge in the same order as that in which the human mind really acquired them—pursuing, as far as possible, the same paths. By the second, the facts and deductions are presented in that order, according to which they might be, at the present day, conceived by a mind which, contemplating them from an appropriate point of view, and armed with sound and abundant knowledge, would endeavour to build up the particular science.

The first method is evidently that by which we must necessarily undertake the acquisition of every growing science, since by this method nothing is required beyond the study of its formation; the process being then reduced to the examination, in chronological order, of the different original works which have contributed to its progress. The dogmatic method, on the other hand, supposes that all previous labours have been cast into a general system, with the view of being presented in a logical and more natural order; and it can only be applied to a science which has attained a high degree of development. But in proportion to the advance of science, the historical manner of exposition becomes more and more difficult, by reason of the long series of intermediate details which the mind must traverse, whilst the dogmatic method becomes more and more easy, and, at the same time, more necessary, because the posterior conceptions permit a presentation of the previous discoveries, under a more direct point of view. To take an example: the education of an ancient geometer, consisted simply in the study of the small number of original treatises then existing upon the different subjects of geometry, and these were chiefly composed of the writings of Archimedes and Apollonius. On the other hand, a modern geometer has usually finished his education without having read a single original work, except those relating to the most recent discoveries, which cannot be known except by this means. The constant tendency of the human mind with regard to the exposition of the science, is therefore to substitute more and more the dogmatic method in place of the historical method, the former being alone fitted for an advanced state of knowledge.

The great problem of an intellectual education consists in advancing an individual mind—usually not of the first class—in the course of a few years, to the same point of development which has been reached during a long series of ages by a great number of superior men, applying all their powers throughout their lives to the study of a particular subject. It must be evident, that although it is much more easy to learn and then to discover, it would be impossible to reach the end in view, if every individual mind had to grapple with all those details which occupied the attention of the original investigators. Hence an indispensable need of the dogmatic method,—a method by which the most advanced sciences are at this day treated, the ordinary mode of exposition showing little trace of the chronological accretion of details.

Nevertheless, it is necessary to add, in order to prevent any mistake of our meaning, that all the modes of exposition in actual use are unavoidably combinations of the dogmatic method with the historical method; but the former must be continually obtaining predominance;—in fact, the dogmatic method cannot be altogether rigorously pursued, since it requires a fresh elaboration of acquired facts; it is not applicable at every stage to the parts recently formed, the study of which only allows of an order essentially historical; and, in such a case, the principal inconveniences of that method are not felt.

The only fundamental imperfection of the dogmatic method is, that it leaves us in ignorance of the manner in which the different branches of human intelligence have been formed; a matter which, though distinct from the acquisition of such branches of knowledge, is in itself of the highest interest to every philosophic mind. This consideration would have much weight in my eyes, were there really anything in it favourable to the historical method. But it is plain that there is no real connection between the study of a science after the historical manner, and a genuine acquaintance with the history of that science. In fact, not only are the various branches of each science (which are studied separately in the dogmatic method) really developed simultaneously, and with the assistance of each other (and this would lead us to prefer the historical method), but, on considering the whole course of the development of the human mind, we perceive that the different sciences have been in truth mutually and simultaneously advanced; we perceive, also, that science and art have exerted innumerable reciprocal influences—that their progress has resulted from their mutual dependence—and, in fine, that both have been closely bound together in the development of human society. This connection is so true, that in order to understand the development of a scientific theory, the mind is led to consider the growth of some art which has no rational relation to it, or even to consider some particular advance in social organization, without which this discovery would not have been made. It follows, therefore, that we cannot truly know the history of any science; that is to say, the history of the discovery of the

facts and principles composing it, except by studying, in a general and direct manner, the history of humanity. And this is the reason why all the documents hitherto accumulated upon the history of mathematics, astronomy, medicine, &c., precious as they are, can only be viewed as materials.

The pretended historical order of exposition, even when it could be rigorously pursued through the details of each particular science, would still be purely hypothetical and abstract in a most important respect, in that it would consider the development of that science as isolated. Far from giving the true history of the science, it would engender false views.

Thus we are certain, that an acquaintance with the history of the sciences is of the highest importance. I am even of opinion, that we cannot have a complete knowledge of any science of which we do not know the history. But the history should be entirely separated from the dogmatic exposition of the science, whilst we keep in mind that the former would be unintelligible without studying the latter.

In order to determine, with all possible precision, the exact difficulty of the question of the encyclopædie arrangement of the sciences, I think it may be useful to introduce a very simple mathematical consideration, which will sum up the preceding reasonings. The problem before us is to class the fundamental sciences. Now, assuming that it is not possible to reduce them to a less number than six, we know that six objects are susceptible of 720 combinations. The fundamental sciences, then, are capable of being classed in 720 different ways; from amongst which we have to select that single classification which best satisfies the terms of the problem. Notwithstanding the great number of arrangements hitherto proposed, only very few of the possible combinations have come under consideration; and yet, I am bold to say, that on examining these 720 modes of classification, there is hardly one, in favour of which something might not be said; for, on observing the different arrangements which have been proposed, we shall find amongst them the greatest differences; the sciences which are placed by some at the head of their systems, being placed by others at the bottom. It is, therefore, in the selection of that single system of classification which shall be truly rational, from amongst the very considerable number of possible systems, wherein lies the great difficulty.

Before we directly grapple with this difficulty, let me first remind the reader, that to obtain a natural and positive classification of the fundamental sciences, we must seek for our guiding principle in a comparison of the different orders of phenomena; the laws of which, it is the object of such sciences to discover. We desire to determine the actual dependence of the different scientific studies. Now this dependence can only result from that of the corresponding phenomena. On considering from this point of view all the observable phenomena, we shall see that it is possible to class them in a small number of natural categories, arranged in such a manner that the logical study of each category shall be based upon a knowledge of the principal laws of the preceding category, and become the basis of the study of the succeeding. This arrangement is determined by the degree of simplicity, or, what comes to the same thing, by the degree of generality of the phenomena, whence results their successive dependence, and, consequently, the more or less facility of their study. In fact, it is clear, *a priori*, that the simplest phenomena—those which are least entangled with others—are necessarily also the most comprehensive, since that which is seen in the greatest number of cases is, on that account, least identified with the circumstances peculiar to each case. We must therefore begin by studying the most general, that is, the most simple phenomena, and afterwards proceed to the more particular, that is, the more complicated phenomena, if we would grapple with physical science in a manner really methodical; since this order of generality or simplicity necessarily determines the logical connection of the several fundamental sciences, by the successive dependence of their phenomena: in this way their degree of facility is ascertained. At the same time, it is important to observe, that the most general, in other words, the most simple, phenomena, being necessarily the farthest removed from man, must needs, for this reason, be studied in a calmer and more philosophic frame of mind; and hence another reason for the rapid development of the corresponding sciences.

We have thus obtained the fundamental rule of classification. Conformably with this rule we are led to divide natural phenomena into two great classes: the first, comprising the phenomena appertaining to inorganic bodies, and the second, those relating to organic bodies. It is evident that the last are more complicated than the others—they depend upon the preceding; whilst, on the other hand, these latter do not depend upon anything else. Hence the propriety of postponing the study of physiological phenomena to that of inorganic bodies. In what manner soever the differences between these two kinds of existences are accounted for, it is certain that we shall find in living bodies all the phenomena, whether mechanical or chemical, which occur in inorganic bodies; and then, a particular kind of phenomena, namely, vital phenomena, or those which pertain to *organization*. We shall not here inquire whether these two kinds of bodies are or are not of the same *nature;* such a question belongs not to the domain of positive philosophy, which distinctly affirms its ignorance of the real *nature* of any body whatsoever. But it is by no means necessary to assume that organic and inorganic bodies are of different natures, to acknowledge the necessity for separating the study of them.

Very likely, ideas are not yet sufficiently settled as to the manner of viewing the phenomena of living bodies. But whatever view we may adopt in consequence of after discoveries, the classification here laid down will not be affected. Let it be regarded as demonstrated (what the present state of physiological science hardly permits us to conjecture), that physiological phenomena are nothing but simple, mechanical, electrical, or chemical phenomena, modified by the structure and the composition proper to organized bodies, our fundamental division will still hold good. It will continue to be true, even under that hypothesis, that general phenomena ought to be studied before undertaking the examination of those special modifications which are met with in certain existences, in consequence of a particular disposition of the molecules. And thus the division which most enlightened persons of the present day make with regard to this subject, founded upon the difference of laws, is of a nature to continue unaltered, on account of the subordination of the phenomena and the sequence of study, whatever connection may be ultimately established between the two classes of bodies.

THE GEOLOGY OF THE OCHILLS.

By Mr. R. Smith, Blackford.

II.

On the north side of the Ochills, are stretched out the fertile plains of Strathallan and Earn. The principal stratum of rock found in these straths is the old red sandstone, interspersed here and there with trap dikes of nearly equal breadth. The direction of these bands is nearly east and west; the most prominent, extending through the valley of Earn, from the Atlantic on the west, to the North Sea on the east, and rising considerably above the earth's surface in the neighbourhood of Muthill and Madderty—at which latter place, it is known as the Crags. It would appear that these trap-rock bands have been formed by a volcanic process; that they have been melted in the interior of the earth, and forced up through the old red sandstone stratum, by the heaving eruptions of fire.

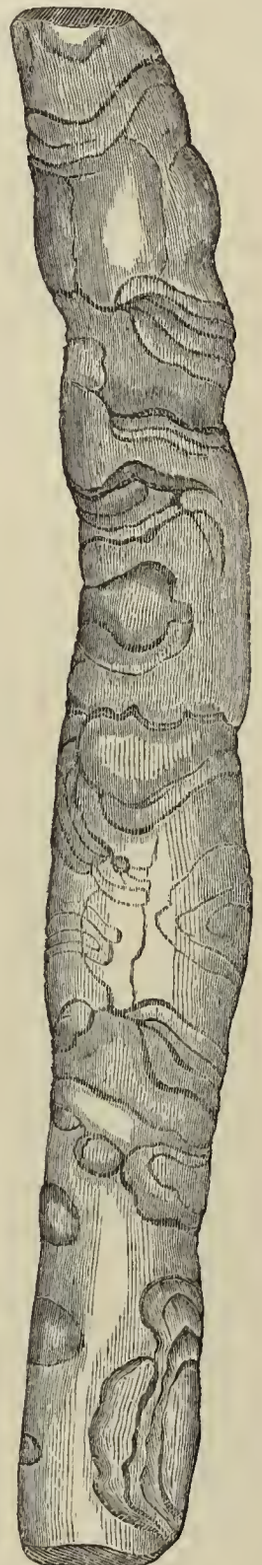
As in the Ochills ridge, the primary and transition formations are prevalent in these plains. Below the old red sandstone, however, the strata have never been examined. The transition rocks partake of the nature both of the primary and secondary formations—apparently forming a passage between the two. The first stratum lying upon the primitive matter, is usually of sandy slate; above which is the greywacke, composed of fragments of earlier rocks, containing an abundance of marine plants—the fossil remains of the Polypi, Ammonite, and Nautilus; above the greywacke is found that species of rock which we know as the old red sandstone, the strong red tint of which arises from the admixture of a quantity of oxide of iron. Next in succession comes the mountain limestone, and afterwards the secondary and tertiary formations. But in this district, the secondary and tertiary formations are nowhere to be found; either they have never been formed, or they have been swept away by some aqueous convulsion of nature; for over the old red sandstone, we find placed diluvium, containing boulders; then beds of gravel and sand, and lastly the soil. From this circumstance, it is easy to account for the absence of coal in this locality, as the coal stratum belongs to the secondary formation; still considerable sums of money have been expended in vain attempts to find it. Boring was for a long time carried on in the vicinity of Dunning, Blackford, Auchterarder, and other places, and a shaft was also sunk to a considerable depth at Tullibardine, of course without the slightest success.

The mineral waters of the locality are saline—as at Pitcaithly, Dumblane, and Airthrie. The following table exhibits the analyses of the two first:—

Dumblane. Analysis by Dr. Murray, in 1814. In an English pint,	grains.	Pitcaithly. Analysis by Dr. Murray. In an English pint,	grains.	Dumblane. Analysis by Mr. R. Smith, in 1848. In an English pint,	grains.
Muriate of Soda,.....	21·0	Muriate of Soda,.....	12·7	Chlorate of Soda,.....	19·0
Muriate of Lime,.....	20·8	Muriate of Lime,.....	20·2	Chlorate of Lime,.....	19·3
Sulphate of Soda,.....	3·7	Sulphate of Soda, ...	0·9	Sulphate of Soda, ...	3·7
Carbonate of Lime,....	0·5	Carbonate of Lime,....	0·5	Carbonate of Lime,....	1·0
Oxide of Iron,.....	0·17	Oxide of Iron, a trace,	0·0	Iodine, a trace,.....	0·0
	46·17		34·3	Bromine, a trace,.....	0·0
				Oxide of Iron, a trace,	0·0
					43·0

In some places, sulphate of barytes, and small veins of carbonate of

copper, are met with in the old red sandstone. The latter was recently met with near Dumblane, in excavating for the Scottish Central Railway; and chromate of iron—chrome ore—was discovered by the writer about two years ago in a field, at a short distance from the village of Muthill. It has only been so far seen in small quantities on the surface, but sufficient to tempt a deeper search, as the ore is largely used for the preparation of salts for dyeing. There also is an abundant supply of water; many of the springs are very large, and so pure that the water may be used for many purposes where distilled water is alone applicable. In Glen-Eagles are two remarkable springs,—one, known as St. Mungo's well, is the source of the Ruthven, and is considered to be the largest in Scotland. The other is also very large, and has been named the Boiling well, from the peculiar appearance of the effluent waters, produced by a covering, on the bottom of the well, of a layer of fine sand. This curious effect is by no means uncommon, but is not met with elsewhere on so magnificent a scale as here.



On this side of the Ochills, in the neighbourhood of the trap rock, a whitish substance, resembling Kieselguhr of Franzensbrunn, is found in large quantities. It is composed of silica, oxide of iron, and fossil infusoria, which are visible under the microscope, when mixed with a little water. The marl and the white earths found here in the peat bogs, are almost entirely made up of the shells and remains of infusoria. Strathallan, from Dumblane to the east of Blackford, is a continued series of hills, or rather knolls, most of which are cultivated from base to summit; and an observer, placed on the Ochills in the morning or evening, before the mists rise from the level ground, will enjoy a very beautiful sight. The scene sometimes resembles an ocean studded with islands, whilst the surface of the waters is calm and placid; anon, as the rising wind acts on the fog, the appearance of a sea-storm is produced—waves roll and foam—islands appear and disappear with great rapidity; at other times, when the mist is lying in detached patches, fairy glimpses of the real landscape are afforded. The knolls are composed of sand and gravel, evidently deposited by water. In those which have been examined in the neighbourhood of Blackford, we find, at a considerable depth, the sand forming into stone, probably from the superincumbent pressure bringing the grains into close contact, whilst the water circulating through the mass, and holding a quantity of oxide of iron in solution, materially assists the process. At the same time, the circulation of the water will cause the newly-formed stone to assume various shapes. Many varieties of stone of this formation have been taken from a sand-bank on the river Allan, a little to the north of Blackford; they contain some very curious representations of foliage and animals.* The annexed engraving represents a specimen in the possession of the writer.

Some theorists have held that these knolls are the remains of glaciers or icebergs, certainly a very extravagant notion; others again incline to alluvial deposition as their origin. But there are many circumstances which are unfavourable to the latter theory; for, had this portion of the earth been covered by the sea, there ought to have been found the remains of marine productions.

The most reasonable conclusion is, that, at a more recent period, the district occupied by the Grampians and Ochills, as well as the sandhills, was an extended plain, and that, by some convulsion of nature, the Grampians and Ochills were upheaved. A quantity of water then flowed in between the two ridges, and on subsiding, probably by finding an outlet to the friths of Forth and Tay, left these knolls; the small lakes and marshes now in existence, being a portion of the water left in the hollows.

OXYGEN.

I.

In the articles, "Curiosities of the Application of Sand," vol. i. p. 12, "Lime," vol. i. p. 207, and "Alumina the Earth of Clay," vol. ii. p. 33, we have endeavoured, in a popular manner, to point out the leading properties of the most useful and most abundant of those compound substances which make up the greatest part of the earth's crust.

We now purpose extending the series by a few papers on some of the *elementary* or *simple* bodies, which not only perform a most important part in the formation of the compound substances, the earths already noticed, but equally pervade the whole of inorganic nature, and reappear in still greater activity in the organic world of life.†

Oxygen, from its activity and universality in nature, and from its being so pre-eminently the connecting link between earth and her children, lays first claim to our attention, and the remainder of this paper will be devoted to the consideration of its properties, and to the history of its discovery, and the circumstances closely connected with it. Oxygen, when prepared with the greatest care, is an insipid and colourless gas, which remains elastic under the greatest pressure and the most intense cold. Its specific gravity is 1·11; that is, in equal bulks, it will weigh nearly one-ninth more than common air. It is called an elementary or simple substance, because all the skill of the analyst fails to extract any *matter* differing from itself. It is said, therefore, to resist decomposition, and the terms *elementary* or *simple* are used in contradistinction to *compound*, which signifies a liability to *chemical* decomposition—*i. e.*, a resolution or separation into ultimate component parts.‡

The importance of this element—oxygen—may be estimated by considering the numberless instances of its presence and abundance. Of silica it forms one half. Here we have a striking example of the vastness of its quantity, and the universality of its presence. Granite, which appears to be the foundation rock of the earth, is nearly pure silica; and we need not remind the reader of our previous article on sand, of many other instances of its presence and value. Next to sand we value lime, and in limestone nearly one-half ($\frac{2}{5}\frac{4}{0}$ths) is oxygen. In clay, more than half is oxygen; and if we were to measure the rocks of the earth, and deduct the amount of sand, lime, and clay—or rather of silica, lime, and alumina—how small a portion would remain; we think less than one-twentieth part of the whole, and oxygen would still have a large share in the remainder. Of the rarer earths, magnesia, barytes, strontia, glucina, &c., it forms a part.§ The metals, well known as they are, form but a very small portion of the soil, yet they are all usually found as oxides, containing from about one twenty-seventh to two-thirds of their weight of oxygen. By far the most generally distributed metal is iron, and it is commonly found as an oxide, containing more than one-third of oxygen. Leave the dry land and turn to the sea. Oxygen forms eight-ninths of water. Mount the air—one-fifth is oxygen. Thus, in the whole domain of inorganic nature, we see the importance of oxygen; and so great is its activity in combination, that it unites with all the known elements, save one (fluorine), directly, and with that one indirectly. Of six hundred and fourteen references in Berzelius' celebrated treatise on the blowpipe, twenty-nine are to minerals without oxygen, and this only when the exceptions are in a state of absolute purity; a circumstance which, in the ordinary course of events, would not occur once in twenty-nine times six hundred and fourteen instances. Absolute purity is seldom attained even by the most elaborate applica-

* The discovery of these interesting natural productions is due to the Rev. John Clark, who has formed a collection of specimens.

† *Inorganic.*—The constituents of the earth, as rocks, stones, minerals, water, air, &c. *Organic.*—The compounds formed by the action of the principle of life, both animal and vegetable. Organic bodies are always compounds; inorganic bodies may be either elementary or compound.

‡ We use the word *matter* advisedly. Latent heat, electricity, and, very possibly, light, if not combined with, are at least very intimately associated with, every so-called element. We regret that the present state of popular science is such as to compel us to use more ambiguous language than we could wish, though we hope it is sufficiently plain to set some of our readers thinking for themselves. As we are constitutionally opposed to mere speculative philosophy, we must at the outset warn against the assumption of any hints as proven facts; and though we shall be very glad to have any one's deliberate opinions, whether in accordance with or opposed to our own, yet we feel quite warranted by our experience to say, we must decline any controversy or disputation, as being more calculated to beget strength of opposition, rather than a just appreciation of truth.

§ The proof of this is due to Sir Humphrey Davy, born 1778, died 1829.

tions of art, more rarely by the unaided efforts of nature; and thus, though regarded as accidental, yet oxygen exists in many, if not in all, of the so-called exceptions in their natural state.

Having thus traced oxygen throughout the inorganic world, it remains to show its importance to the organic; but we must content ourselves with a mere allusion to its activity in the compounds pertaining to vitality, reserving a more extended enumeration of its services in this particular, until, in our future essays, we can consider the compounds themselves. Beginning with the link between stone and vegetable—coal, we find it present in quantities varying from three to thirty per cent. In wood—*i. e.* the basic or solid part of all plants—and in flesh, it is equally abundant, and even more essential, and it is absolutely necessary for the due performance of the highly important function of respiration.

The industrial arts are greatly indebted to its services. Metals are extracted from their ores by its withdrawal, and, on the other hand, the colours of the painter and the dyer are frequently due to its addition. With lead it forms litharge and red lead; with iron, crocus. Indigo, partially deprived of it, becomes soluble and colourless, penetrates the finest tissues, then re-absorbs it, becomes brilliant and permanently fixed. Bleaching is often effected by its assistance, and vinegar-making is entirely dependent upon it. Sulphuric and nitric acids are the results of its combinations with sulpbur and nitrogen, and through these two acids it is introduced into countless operations of manufacture. We have intentionally delayed until now auy mention of its most important duty —its activity in ordinary combustion; and it must be remembered that respiration causes the combustion of the principal portion of our food. The atmosphere is the source whence our fires derive their supplies, and to withhold it is to extinguish them.

In combustion, oxygen unites with the burning body, and at the same time heat is always, and light often, most freely evolved. A body, therefore, is not annihilated by burning, but its constituent principles are liberated entirely, or form fresh combinations with oxygen, and thus *every substance acquires weight by combustion, the increase of weight being exactly that of the oxygen absorbed.*

The product of combustion may be a gas, as when charcoal is burnt, and forms carbonic acid gas; a liquid, as when hydrogen is burnt, and forms water; or a solid, as when zinc is burnt, and forms an oxide or calx. Hence oxygen has been termed "*the* supporter of combustion." This is not quite appropriate, though of ordinary combustion it appears* to be true. We will, however, mention two of many exceptions: hydrogen and most of the metals burn with chlorine and with sulphur, oxygen being entirely absent. Besides, we cannot strictly apply the term "supporter of combustion" to one body only. A jet of hydrogen appears to burn in an atmosphere of oxygen, but equally the same effect results from an ignited jet of oxygen in an atmosphere of hydrogen. In the patent smoke-consuming furnace of Mr. Charles Wye Williams, iron pipes, perforated witb numerous holes, admit jets of common air—and consequently oxygen—into the heated smoke. On looking into the flue, it would seem that jets of inflammable gas were issuing from the various holes and burning in air, whilst the fact is the reverse—jets of air are issuing into the gas of the smoke, and *which* is to be called "*the* supporter of combustion" we are unable to decide, for both are equally active; it reminds us of the negro's pair of dogs—"Massa! 'um dogs 'dentical like —'specially Pompey." The peculiarity of the position has also been illustrated as follows:—Could we live in an atmosphere of coal gas, and have gas-pipes supplied with oxygen, each jet would afford a flame as brilliant as now, and we should say, oxygen was burnt, and coal-gas supported combustion; whereas we now say just the reverse. Though oxygen cannot lay an exclusive claim to the honours of the pbenomena of combustiou, yet it possesses many very remarkable properties, which are strikingly exemplified when the gas is pure. A candle with a long snuff being extinguished, and immediately plunged into a jar of oxygen, is instantly reignited, and burns with far greater brilliancy and rapidity. A piece of glowing charcoal, immersed in an atmosphere of oxygen, burns in a most brilliant manner, giving off showers of most splendid sparks; and if attached to the end of an iron wire, or, still better, a piece of steel watch-spring, the metal also becomes ignited, and burns even more rapidly than a pine-match in common air. The most vivid light, though the most transient, is produced by the combustion of phosphorus. The result of these combustions is in every case an oxide; this term being used in its general sense, as applied to all bodies combined witb oxygen. Charcoal, burnt in oxygen, combines with it to form an oxide, which is also a gas at ordinary temperatures and pressures, and is well known as carbonic acid gas. Iron, in the same circumstances, yields an oxide of iron, resembling that formed on hot iron in the open air—smiths' scales. It will be noticed, that in these instances one product is called an acid, and the other an oxide; both are compounds of oxygen with other substances, and therefore, in a general sense, are both oxides; but the terms in scientific language are employed with a view to mark the leading peculiarity of the products, bodies called in technical phraseology—acid, possessing certain distinctive properties from those to which the term oxide is arbitrarily confined. It will thus be evident that all oxides are not acids, but the reverse was at one time the generally admitted theory; and hence the name oxygen, derived by Lavoisier, the French chemist, from two Greek words, signifying "acid maker," for he held that all acids were oxides. It has since been shown that there are true acids without oxygen, the most generally known being hydrochloric acid, a name synonymous with muriatic acid, marine acid, and spirits of salt. But we are no sooner clear of one theoretical difficulty than we fall into another; for it has subsequently been urged, that as there are true acids in which hydrogen and not oxygen is present, and as none of the so-called oxygen acids exhibit their acid properties in the absence of water—a compound of hydrogen and oxygen—therefore, there is no real acid without hydrogen, and *it* should be called "acid maker." In short—or very nearly—that oxygen and hydrogen should change names. "Who shall decide when doctors disagree?" we shall therefore leave this very pretty quarrel as it stands.† This controversy is a very good illustration of one of the many difficulties attending a speculative theory. Many are the dangers incident upon a theory which cannot accept a fact as a fact, but must weave some fine-strained web of special pleading, in the vain hope of controlling these stubborn realities. To many it may now appear to be out of date, if we advocate a strict regard to experiment. The superficial observer may consider he has sufficient guarantee against hypothetical perversion, in the respect paid to the memory of Lord Bacon, the founder of experimental philosophy, and in the fashionable pursuit of *soi-disant* practical science. But let us illustrate our meaning by an example: The doctrine of chemical equivalents, or proportionally combining weights, appears to be as clearly demonstrated as tbe present state of science will admit; but who can point to one fact that proves the existence of atoms? *i. e.* little indivisible, unalterable, unchangeable lumps! yet active everywhere but in themselves, for in their own diminutive bodies they are impenetrable, and possess nearly every negative quality. We should not call a Maypole au active agent, merely because it was surrounded by a troop of dancers; we should say the dancing was owing to the actors, and not to the Maypole. We should also say tbat they could choose their own steps and figures, and that the nature of the dance would in no way depend upon the nature of the pole, or centre of attraction. And further, that if anything was really requisite to limit their movements, it might with equal reason be external or internal; they might discard the pole, and confine themselves within the circumscribing walls of a room, or amidst the intervals of otber circles—like the bubbles of foam—as well as round a solid centre or atom. So with matter. If it is composed of small solid centres—Maypoles—possessing all their powers and forces of gravity, electricity, repulsion, attraction, &c., the dancers around them, in what do they differ from our rather fanciful suggestion? And when we consider the difficulties of the atomic theory, respecting light, heat, and electricity—difficulties, many of which are beautifully set forth and illustrated by facts in Faraday's speculation touching electric conduction and the nature of matter—*Practical Mechanic's Magazine*, vol. iii. page 197—may we not think this guess to be even nearer the truth? a guess which supposes the dance to rest with the dancers, and not with the stick in the centre. But it is impossible to exercise too much caution in adopting a theory upon the most plausible supposition—true it is, that

> "Dangers past all calculation,
> Beset the man of speculation;
> Who, to possess an easy mind,
> Should be half deaf and nearly blind."

The generalising of facts, and the reducing practice into science, is, and should be, the aim of every true philosopher; but we raise our voice against the morbid over-anxiety which leads us to accept a theory upon

* We say *appears*, because the modern material atomic theory scarcely admits of the presence or action of the substance, force, or property—heat—as an *essential;* and if, at some future day, heat, or some analogous principle, should be shown or be supposed to have a positive and individual existence, then, as heat is present in every case of combustion, the modern theory may be upset, oxygen discarded from the list of active agents, and heat, or its relation, be substituted in its place. We say this, not from any desire to render a rough road still more toilsome, but to remind the reader that many modern chemical theories—*i. e.* hypothetical explanations of chemical phenomena—are merely guesses at truth. They may be, and we think frequently are correct, but we must warn against their too ready reception as absolute demonstrations.

† Anhydrous, *i.e.* perfectly dry sulphuric acid, by fusion with caustic alkalies, forms sulphates; so does silicic acid form silicates; both being examples of the acid action of bodies containing no hydrogen, they have been held to prove the activity of pure oxygen acids; all going to prove the old legal axiom, "that a great deal may be said on both sides."

data that after-experience shows are at least uncertain, if not positively unsound. We cannot object to guesses, provided they are borne in mind as guesses merely, and are not laid down and accepted as demonstrations; but we confess we have but little patience with those teachers who take up a plausible theory, say, "it is," when they should only say, "it may be," and for no other reason than that it is the fashion to be dictatorial, and that they hope by these means to pass themselves off for such great wiseacres, that nature's most hidden mysteries are all open to their lack-lustre eyes. They, forsooth, know all about it—"certainly," say they, "it does appear strange to the uninitiated, but just try a dose of our theory, it will so brighten your wits and open your eyes! There, place two marbles—the harder the better—side by side; take care they do not even touch—cry, 'Hey, Presto!' that is our chemical combination." We certainly prefer a child's idea of the manner in which two fluids, as whisky and water, are said to mix—and think such a notion of what is admitted to be merely a mixture, coincides much better with the idea of intimate chemical combination, than the lump upon lump theory which has resulted from the prolonged labours of many most ingenious men—whose work, despite their talent and perseverance, we can only regard in the same class as highly elaborate automata, intricate examples of ingenuity misapplied and incomprehensible to all who have not been trained up to the craft. It would almost seem that one of the first principles of morals had been found inapplicable to science, and that, in such a matter, it *was* right to do a little wrong that good might come. Much of the modern chemical theory rests on a good foundation, but is an unfinished superstructure. To have exhibited the incompleteness of the building would have incited others to the task, but alas! it would also have shown the theoriser's ignorance; they have therefore built "castles in the air," whose hollow paper walls awe the multitude by an imposing aspect, and, upon close inspection, present an excellent example of the skill of the contrivers in an elaborate arrangement of patch-work. We do not come prepared with a theory that shall supersede the present one. We know where the shoe pinches, and are willing to admit, that we are neither shoemakers nor cobblers, to know how to remedy the defect. We therefore cry out when we are hurt, and are not disposed to agree with those who say, "Do not meddle with what you have got—even if it pinches rather too tight—unless you can produce a better." On the contrary, we think we are really forwarding the cause of truth by saying—"Here is a difficulty, who will help to remove it?" Our dissuaders would say—actively or tacitly—"Get away with you! though we are in a mess, yet we would rather continue to be entirely dirty than partially clean." So would not we, but would always take half a loaf when we could not get a whole one, and rather than be without any.

In any inquiry where truth is sought, we hold that doubts, as well as faith, should be discussed. If we cannot arrive at a satisfactory conclusion, let us seek more and clearer evidence; but if we would be honest judges, let us have no decision where the evidence is inconclusive, or the question has not been seen on all sides. Better to say—"We cannot tell," and frankly admit that we do not know that which is hidden, than to say—"This is right," when after-proofs may upset our hasty judgment, and posterity point to our sapient selves, exclaiming—"These are our Solon forefathers, who undertook to settle what they did not understand."

We cannot better illustrate the dangers and progress of hypothesis, than by giving the history of oxygen, both when ill-treated and stifled by its rival, phlogiston, and when discovered and almost restrangled by Priestley. "What man has done, man may do." So said our schoolmaster; and it will aptly apply as the moral we would wish the following short history to inculcate, if we interpret the phrase in a way our "dominie" did not exactly intend, by saying—"Speculative men have made many mistakes, and speculative men will most probably do so again." In our compilation, we have borrowed freely from the works of Thomson, Brande, Turner, and Fourcroy.

The first idea of the phlogiston theory is ascribed to John Joachim Beecher. He was born at Spires, in Germany, in 1635, and, by a succession of intrigues, was driven from Munich to Vienna, thence to Haerlem, and eventually, in 1680, to Britain, where he examined the Scotch and Cornish mines and smelting, and died after a few years' residence. The development and nomenclature of the theory are due to George Ernest Stahl, born at Anspach, 1660, and died 1734. He contributed so greatly to its success, both by his reasoning and experiments, that although it originated with Beecher, yet it was commonly called the Stahlian theory. According to this theory all combustible bodies are compounds, one constituent being set free and dissipated by combustion, the other being fixed and remaining. Those bodies which will not burn, were said to have previously undergone combustion. Thus, quicklime possesses properties very similar to the calces of the metals, *i.e.* the products of their combustion, and it was very naturally supposed to be also a calx, and that, if the matter dissipated during its combustion could be restored, lime would be converted into a metal. Combustibility was therefore thought to be dependent upon an igneous or fiery principle, or material substance, which was present in every combustible body, and whose separation constituted the phenomenon of combustion. This substance was considered to be absolutely the same in every combustible, their individual peculiarities resulting from the other principle, or number of principles, with which this common fire-principle was combined. For this common principle Stahl invented the name, Phlogiston, and in proof of the theory he adduced experiments which appeared so decisive and incontrovertible, and were stated with so much force and clearness, that the idea was received almost by acclamation, and the dissentients found themselves in so small a minority, that most lost courage to express their dissatisfaction, and thus tacitly sanctioned its reception. The experimental proofs, and theoretical deductions, were as follows:—When phosphorus is burnt in a glass vessel, the white smoke produced during the combustion is deposited on the glass, and, quickly absorbing moisture, deliquesces into an acidulous liquid, known as phosphoric acid. This liquid, placed in a platinum crucible, and gradually heated to redness, parts with the water, and leaves dry phosphoric acid, which is colourless and transparent, like glass. If a quantity of charcoal is mixed with this phosphoric acid, and the whole reheated in a close vessel, a portion, or the whole, of the charcoal will disappear, and phosphorus will be found, in every way identical with that burnt in the first instance. The conclusion deduced from this appears to be inevitable—the charcoal had combined with the phosporic acid, and the union of the two bodies constituted phosphorus. To corroborate their views, the advocates of the phlogiston theory appealed to the action of nearly every inflammable substance. They showed that a similar effect was produced by lampblack, sugar, resin, and flesh, and also by the more easily oxidized metals, as zinc, and that in every case the mixture of a combustible with phosphoric acid produced phosphorus. Hence it appeared to be a necessary consequence, that all combustibles possess one common principle, which they communicate to the phosphoric acid; for as the body formed by the action of each combustible is, in all cases, identical, and, moreover, as one combustible produces another—as, in the foregoing instance, charcoal produces phosphorus—therefore the principle communicated by, and necessarily a constituent of, every combustible, must be identical also; and that supposed principle was named phlogiston. The theory was also argued by the aid of all similar phenomena. Sulphur, by burning, is converted into sulphuric acid, and if it is then heated with charcoal, sulphur is reproduced. Who could deny the inference—that the combustible or phlogisticated substance imparted its phlogiston to the burnt or dephlogisticated substance, and thus reproduced the original phlogisticated compound? Again: tin at a red heat becomes converted into a calx. "By this process," said the phlogistians, "the tin becomes dephlogisticated, and when we wish to reproduce the metal, we have only to add phlogiston to the calx which has been deprived of it. This we do by heating it with any combustible body; and it is indifferent whether we use wood, peat, coal, charcoal, leather, hair, sugar, flour, horn, &c., all will equally reproduce the tin, and must therefore all communicate the same substance to it—that substance is phlogiston." But there was a difficulty in the way, and though it appeared to be the only one, yet it finally overthrew the theory; and it is remarkable, that the fact which formed the wrecking rock, should have been observed and recorded many years before the well-pleaded theory had been framed.

About 1630, Jean Rey, a physician at Bugue, in Perigord, France, published his investigation of a circumstance referred to him by Le Brun, who found that 2 lbs. 6 oz. of tin, kept at an elevated temperature for six hours, had passed into the state of calx, and then weighed 3 lbs. 1 oz.; that is, dephlogisticated or burnt tin is *heavier* than phlogisticated or unburnt metallic tin. Rey thus sums up the result of his labours: "To this question, then, supported on the grounds already mentioned, I answer, and maintain with confidence, that the increase of weight arises from the air, which is condensed—rendered heavy and adhesive, by the violent and long-continued heat of the furnace. This air mixes itself with the calx—frequent agitation conducing—and attaches itself to the minutest molecules, in the same manner as water renders heavy sand which is agitated with it, and moistens and adheres to the smallest grains." This difficulty—the increase of weight consequent upon *dephlogistication*—was met by assigning a peculiar property to phlogiston. It was supposed to be not only destitute of weight, but absolutely endowed with the property of levity. A body containing phlogiston was said to be lighter than it otherwise would be, and became heavier when the phlogiston made its escape. Thus, the increase of weight in the calcined tin was not owing to the fixation of air, but to the escape of phlogiston,—in other words, of so much lightness. This ingenious

sophism of the phlogistonic chemists upon the property of levity, is only equalled by the speculation of a very sanguine inventor, who, instead of considering the *comparative* lightness of hydrogen—the lightest substance known, the gas frequently used for filling balloons—ascribed it, after the same logical manner, to the innate property of levity, and, in sober earnest, proposed to condense a balloonful into a vessel to be contained in his hat, which, when thus endowed with all the *levitating* powers of the balloon, was to be strapped to his shoulders. Thus equipped, off he was to fly—we suppose—to Gulliver's island of Laputa, the happy abode of tremendous geniuses, where he was to be met by his near relation, who would condense into his snuff-box sufficient air to float him conveniently on the water, put his box in his waistcoat pocket, "walk the waters like a thing of life," and feed during the voyage upon "*the quintessence of dinner lozenges*," commodiously packed in a pill-box. It must he remembered, that upon this circumstance, the increase of weight by combustion, rests the proof of the part performed by oxygen. If charcoal combined with phosphoric acid to form phosphorus, the phosphorus should weigh as much as the united weights of the charcoal and acid. This is not found to be the case, but, on the contrary, it is considerably lighter. It is also ascertained, that when charcoal and phosphoric acid are heated together, a gas is evolved—invisible, and therefore very likely to escape notice—which, when collected, is found to weigh as much as the charcoal *and* the weight lost by the phosphoric acid; the loss being also exactly equal to the weight gained by the original combustion of the phosphorus, and its conversion into phosphoric acid. Hence the moderns conclude, that phosphorus, in burning, combines with a gas (oxygen), and therefore becomes just as much heavier as the gas weighs with which it combines. When the acid is heated with charcoal, it is decomposed, the oxygen unites with the charcoal to form an oxide of carbon—also a gas—and the phosphorus remains, of the same nature, quantity, and weight as before combustion. So far as this goes, we think it clearly proved; and much as we may be inclined to doubt, in this instance we can scarcely agree with Abraham Tucker, as quoted by Bulwer in the Caxtons, though—like many other advice-givers, who recommend more than they appropriate—we think his works are worthy of the best consideration of all strongly-opiniated persons: "Well persuaded as I am that two and two make four, if I were to meet with a person of credit, candour, and understanding, who should sincerely call it in question, I would give him a hearing; for I am not more certain of that than of the whole being greater than a part, and yet I could myself suggest *some considerations that might seem to controvert this point.*" One grave objection to the modern theory is the absence of all recognition of heat, light, and electricity, as *essentials* in the various phenomena. They are always present, and frequently are obviously necessary; can it then be possible for that theory to be correct which barely recognizes their existence? We think not; and our own inability to frame a theory which, in strict accordance with facts, shall embrace the whole of these phenomena, does not prevent our acknowledgment of ignorance, but most certainly will enhance our gratitude to him who can grasp the subject with such a master-hand as to discover and lay bare the wondrous laws by which nature rules the endless combinations of the material world. Our gratitude is also due to every one who advances us a single step towards truth. We honour the recorder of a simple fact, especially if it be opposed to a favourite theory; and shall therefore first enumerate some of those who, though in the merest twilight of theory, were yet content to curb their imaginations by the evidence of their senses, and who practised the philosophic precept—"facts not fictions." We shall then speak of oxygen and its discovery, and conclude with a short notice of the architect of much of the modern theory of combustion and acidification.

NOTON'S TAKING-UP MOTION FOR POWER-LOOMS.

We have already briefly introduced Mr. Noton's clever invention to public notice, under the head of "Improvements in Power-looms," at page 206 of our second volume; and we are now enabled to give a clearer idea of its action, by the assistance of the annexed engravings.

Fig. 1 is a partial side elevation of a power-loom, with the taking-up motion attached; and fig. 2 is a corresponding front view. The ratchet-wheel, 4, drives the usual gearing, 5, 6, 7, and 8; the last wheel, being fixed on the emery-roller end, drives the wheel, x, which is an additional wheel placed on the end of the cloth-beam.

The wheel, x, runs loose upon the cloth-beam shaft, and the face of it is turned smooth, so that it can be made to act as a friction-plate, when it is brought in contact with, and pressed to another disc, which is effected in the following manner:—1, 1, are two nuts screwed on the end of the shaft, 2 is a washer, and 3 is a friction-plate made fast upon the beam shaft. When the nuts are screwed up, it brings the face of the wheel, x, in contact with the friction-plate, 3, and by that means gives motion to the cloth-beam.

The greatest nicety of tension can be given to the cloth by the slightest alteration in the nuts 1, 1. It is necessary that the cloth-beam

Fig. 1.

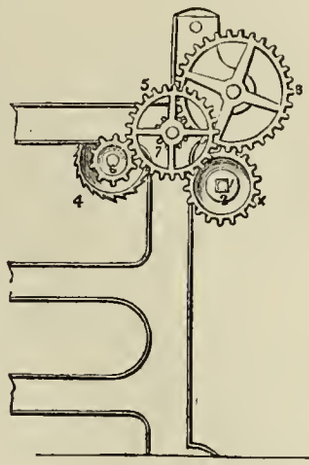
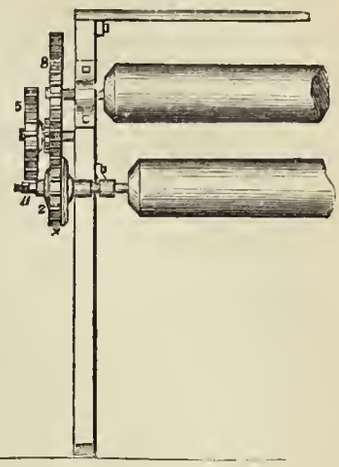


Fig. 2.



should be driven quicker than the emery-roller (say ¼th quicker), so that the cloth may at all times be taken up and wound on the cloth-beam with ease, as fast as it is delivered by the emery-roller, and at the same time, always by the action of the friction-plates, keep a uniform tension on the cloth. If a *thick* piece of roller-cloth be placed between the friction-plates, and likewise a little leather, or cloth, put between the washer 2, and the face of the wheel, and the cloth rubbed over with black-lead, it causes the motion to work exceedingly easy and free.

TERRESTRIAL MAGNETISM.

When a magnetised needle is freely suspended by a silk thread at its centre of gravity, it will be found to point one of its extremities in the direction of the north pole of the earth. But at most places on the earth's surface its direction does not coincide, and therefore forms an angle with the geographical meridian. This variation from the geographical meridian is termed the *declination* of the needle. Moreover, it is only at a few places that its direction is in the plane of the horizon; it is generally found to point in a sloping direction towards the earth, and the angle of divergence from the horizontal plane is termed the *inclination*, or dip. Again, it is found that the needle is not everywhere attracted with the same energy. The intensity of total magnetic force, as it is termed, is measured by the power with which, when withdrawn from its position of equilibrium, it strives to return to it. The magnetic state of any place is not deemed determined until these three elements—the declination, inclination, and intensity—are precisely ascertained. It has been estimated by Gauss that the total magnetic power of the earth, compared with that of a saturated steel bar, 1 lb. in weight, is as 8,464 millions of millions to one; and supposing it to be evenly distributed, the force in every cubic yard of the earth's mass will be equivalent to that of six such bars.

1. *Declination.*—There are certain points on the globe where the direction of the needle exactly coincides with the geographical meridian, and lines which connect such points with each other are termed *lines of no declination.* Lines which connect points where the needle is deflected by the same angle from the geographical meridian, are called *isogonal* lines. Such lines on a sphere, which may be termed magnetic meridians, are curves of double curvature. They are not parallel with each other, but are bent into unaccountable flexures. Most of them are found converging towards a point in each hemisphere—one being near Baffin's Bay, and the other to the southward of Van Dieman's Land. The changes of declination in sailing along some geographical meridians is so rapid, that it has been proposed, where the indications of the chronometer cannot be trusted, to determine the longitude by means of the compass. Sir James Ross, whilst voyaging in the Antarctic Ocean, once noticed a change in the declination from 114° west, to 40° west, in a space of about 360 miles.

2. *Inclination.*—A line drawn through those points where the needle's direction is parallel with the plane of the horizon is termed the *line of no dip*, or the magnetic equator. It forms a curve of double curvature, and cuts the earth's equator at two places. To the north of this line the needle inclines its northern extremity more and more, until, at the north magnetic pole (70° north latitude, and 95° 39′ west longitude), it points

vertically downwards. On the other hand, to the south of this line the southern extremity of the needle is pointed towards the earth, and at the south magnetic pole (75° 5′ south latitude, 154° 8′ east longitude), it is again in a perpendicular position. "As we approach the magnetic equator," says Sir James Ross, "our observations relative to this interesting question were more frequent. We had watched the progressive diminution of the dip of the needle, and, steering a course as nearly south as the wind permitted, in order to cross the line of no dip at right angles, we found the change so rapid as to he ascertained with great precision; so much so, that the signal for our being on the exact point of no dip—where the needles, being equally poised hetween the northern and southern magnetic systems, assumed a perfectly horizontal position—was being hoisted from both ships at the same instant of time. It could not fail to be of more than ordinary interest to me to witness the needle thus affected, having, some years previously, when at the north magnetic pole, seen it in a directly *vertical* position; nor was it unnatural, when we saw the south pole of the needle beginning to point below the horizon, to indulge the hope, that ere long we might be permitted to see it in a similar position at the south magnetic pole of the earth. The regularity as well as the rapidity with which the alterations of dip oeeur is also worthy of notice. At 280 miles north of the magnetic equator, the dip was 9° 36′, showing about 2·05 minutes of change for every mile of latitude; at 292 miles to the south, the dip was 9° 52′, or about 2·03 minutes for every mile of latitude. It is to he remembered that this large amount of change is limited to the region of the magnetic equator; near the poles it requires an approach of ahout two miles to produce an alteration of a single minute of dip." The magnetic poles, it will be noticed, do not coincide with the geographical poles. Lines which connect points, where the dip of the needle is the same, are termed *isoclinal lines.*

3. *Intensity.*—It was formerly supposed that the intensity of the force which determines the magnetic declination and inclination is at a minimum, where the dip of the needle is zero, *i. e.* where the needle is parallel with the plane of the horizon. But this is not the case; and henee, since Humboldt selected the magnetic intensity at a certain place in Peru, where the needle took a horizontal position as the unit measure, it has beeome necessary, when his scale is adhered to, to employ expressions less than unity to denote the intensity at many places where the magnetic force is more feeble, although the deviation from the horizon is greater.

Researches, says Sabine, into the amount of the magnetic force at different points of the earth's surface, and graphical representations of the results by lines drawn through the points where the force has an equal intensity (*isodynamic lines*), have shown that there are two foci, or points of maximum force, in each hemisphere, and consequently four on the whole surface of the globe. The isodynamie lines which surround each of the two points of maximum in a hemisphere are not cireles, but are of an ovate form, having the larger axis in a direction which, if prolonged, would connect the two foci hy the shortest linc, or nearly so, whieh can be drawn between them on the surface of the globe. As the ovals successively recede from the focus, they correspond to weaker and weaker degrees of force, each in its turn enclosing the ovals of higher intensity. This continues to be the ease until the two systems of ovals encounter in a point intermediate between the foei. The isodynamic line whieh corresponds to the force at this point, has, consequently, the form of a figure of 8, each of the loops enclosing a focus with its surrounding ovals. This form is called hy geometricians a lemniscate. There is but one such isodynamic line in the extra-tropical part of each hemisphere, and it separates the isodynamics of higher intensity than itself which are within the loops, each surrounding a single point of maximum only, from those whieh correspond to weaker degrees of force than that of the lemniscate, and are exterior to it. Each of the exterior isodynamics surrounds both the foci, but without meeting or erossing in the point between them. Their general form is that of parallelism with the external figure of the lemniseate, but the inflections which produee the double loop become progressively less marked in the isodynamics of weakest force.

If the two foei in a hemisphere (continues Sabine) were points of equal force, the ovals surrounding each would be similar in force and area, and the point at which the two systems would enconnter each other would be half-way hetween the foci. Such, however, does not appear to be the case. The intensity at one of the foci is greater than at the other; it is so in both hemispheres, and the ratio of the force at the major and minor focus appears to be nearly the same in both. The two major foei —one in the northern, the other in the southern hemisphere—are not at opposite points of the globe to each other, nor are the two minor foei. The foei in each hemisphere are not separated from each other by an equal numher of degrees of geographical longitude; they are nearer to each other in the southern than in the northern hemisphere.

None of the foci of maximum intensity is coincident with the spot in which the direction of the needle is vertical. In the northern hemisphere, the geographical position of the focus of maximum intensity is in latitude 52° 19·3, longitude 268° 0·1.

In passing from the north to the south magnetie hemisphere, there is upon every meridian a point up to which the intensity gradually diminishes, and from which, in continuing a southward progress, it begins to increase. The line uniting these points is one of various inflection, and in it occurs the point of minimum total intensity, or the place whose magnetic intensity is exceeded by that of every other place on the earth's surface.

The mode of measuring the magnetic force in parts of an absolute scale, instead of in Humholdt's manner, has of late been adopted in eonsequenee of its enabling present determinations to be eompared with future ones. In this scale the unit of force is that amount of magnetic force required to generate the unit of velocity in the unit of mass during the unit of time. If a British foot, grain, and second, be taken to represent these units, the ratios of force at the major and minor foci in the northern hemisphere are 13·9 and 13·3; in the southern hemisphere, 15·6 and 14·9. At St. Helena, which is nearly in the line of least intensity, the value of the force is 6·4.

Variations in the Position of the Needle and in the Intensity of Magnetic Force.—Such variations as depend upon changes of place have been already mentioned, but there remain to he noticed those variations whieh have reference to time.

Periodical Movements.—In every 24 hours the needle is found to make two deviations to the eastward, and two to the westward, of its mean position, those which take place in the day being greater than those occurring in the night. The extent of the deviation is greater in summer than in winter. Finally, a fluctuation having an annual period has been discovered. The angle of dip has been found to vary in a similar manner; and the intensity of total magnetic force is likewise subject to fluctuations of the same character. These fluctuations are attributed to electric currents caused by changes in the amount of heat communicated by the sun to the earth and its atmosphere.

The amount of diurnal variation decreases as the magnetic equator is approaehed.

The diurnal variations in the southern hemisphere are in a direction opposite to those in the northern. Hence it was thought probable that there might exist a line where these diurnal variations are no longer observahle. But it appears from observations, made at stations which were suitable for determining the question, that those variations, which are peeuliar to each hemisphere, prevail at opposite seasons of the year, apparently in aceordance with the position of the sun with relation to the earth's equator.

Seeular Variations.—In the periodical displacements, the movement of the needle at one time is compensated by a counter movement at another. But it has heen found that, after allowing for movements of short period, there still remains a small displacement of the needle, by which its mean position is slowly advancing in one direetion. Hence, all the magnetie curves are slowly but regularly changing over the whole surface of the earth; they are sweeping round upon the two hemispheres in contrary directions. The points of similar intensity are being disturbed along with the rest; and, from comparing the ohservations of Sir James Ross in the Atlantic with earlier observations in the same ocean, it would seem that the line of least intensity has been there moving northerly, during the last fifteen years, at the rate of rather more than thirteen miles annually.

In addition to the periodical and secular movements, the needle is subject to irregular perturbations, which—when of a sudden and violent nature, as they frequently are—have received the name of *magnetic storms.* Sometimes the perturbations are scareely perceptible; but at others, the needle gradually moves without oscillation over several degrees to some fixed point, from whieh it will return in the course of a few minutes. On some rare occasions, the needle is capriciously agitated in a peeuliar way. These disturbances are simultaneously propagated over vast regions; they have even been synchronously ohserved over the whole surface of the globe, so that the needles in observatories thousands of miles apart are seen mysteriously to tremhle at precisely the same moment. The synchronism of the perturbations, however, is not confined to the larger and extraordinary changes, but even the minutest deviation at one place of observation has its eounterpart at another.

Hypothesis of Terrestrial Magnetism.—One hypothesis regards the earth itself, as intrinsically magnetic in the sense that a loadstone is magnetic; but, in this hypothesis, it is difficult to account for the secular variations of the magnetic curves. Another hypothesis assumes that the seat of the earth's magnetism, if not entirely atmospheric, is at least so far superficial, as to be subject to external influence to a large amount, and the

magnetic curves bearing no relation to any fixed lines in the globe, or to any determinate directions in external space. It is to be noticed, that Professor Barlow was able to imitate, on an artificial globe, most of the phenomena of the magnetic needle, by passing electro-magnetic currents round its surface.

Terrestrial magnetism, in its present state (says a Report of the Council of the Royal Society), subdivides itself into two chief branches, which bear a certain analogy to the theories of the elliptic movements of the planets, and of their periodical and secular perturbations. The first comprehends the actual distribution of the magnetic influence over the globe at the present epoch, in its mean or average state, when the effects of temporary fluctuations are either neglected or eliminated, by extending the observations over a sufficient time to neutralize their effects. The other comprises the history of all that is not permanent in the phenomena, whether it appear in the form of momentary, daily, monthly, or annual change and restoration, or in progressive changes, not compensated by counter changes, but going on continually accumulating in one direction, so as, in the course of many years, to alter the mean amount of the quantities observed. These last-mentioned changes hold the same place in the analogy above alluded to with respect to the mean quantities and temporary fluctuations, that the secular variations in the planetary movements must be regarded as holding with respect to their mean orbits on the one hand, and their perturbations of brief period on the other. There is, however, this difference, that in the planetary theory, all these varieties of effect have been satisfactorily traced up to a single cause, whereas, in that of terrestrial magnetism, this is so far from being demonstrably the case, that the contrary is not destitute of considerable probability. In fact, the great features of the magnetic curves, and their general displacements and changes of form over the whole surface of the earth, would seem to be the result of causes acting in the interior of the earth, and pervading its whole mass; while the annual and diurnal variations of the needle, with their train of subordinate periodical movements, may, and very probably do, arise from, and correspond to, electric currents produced by periodical variations of temperature at its surface, due to the sun's position above the horizon, or in the ecliptic modified by local causes; while local or temporary electric discharges, due to thermic, chemical, or mechanical causes, acting in the higher regions of the atmosphere, and relieving themselves irregularly or at intervals, may serve to render account of those unceasing, and, as they seem to us, casual movements, which recent observations have placed in so conspicuous and interesting a light. The electro-dynamic theory, which refers all magnetism to electric currents, is silent as to the cause of those currents, which may be various, and which only the analysis of their effects can teach us to regard as internal, superficial, or atmospheric.

THEORY OF THE MOLECULAR CONSTITUTION OF BODIES.

By D. O. J. Brock, Professor of Mathematics in the Royal University of Christiania.

All bodies are supposed to consist of very small indecomposable particles, named atoms, which form groups, termed molecules. The immanent forces of atoms, which lead to the formation of molecules, are named atomic forces, and, being of a chemical nature, are incapable of decomposition by any mechanical power soever. For mechanical purposes, the molecule may therefore be regarded as the fundamental element of bodies.

The molecules are kept at certain distances from each other, by a force named molecular force, which exhibits itself in the form of attraction when the space between the molecules is increased, but in the form of repulsion when such space is lessened.

We can, consequently, consider the molecular force as the result of two forces, the one attracting, and the other repelling, both of which are diminished as the distance is increased, but so that the latter decreases more rapidly than the former. We are still ignorant of the law of these forces when operating at very small distances; but when the distance is measurable, the molecular force is seen only in the form of attraction, and operating with an intensity directly proportional to the product of the mass of the two molecules, and inversely proportional to the square of the distance. This attracting force is named the universal power of gravitation, while the name of molecular force is confined to those cases when it operates at very small distances.

The molecular force not only retains the molecules of bodies at their determinate distances, opposing therefore all changes of volume, but it often retains the molecules in a fixed position, relatively to each other, and therefore resists with a certain force every alteration of form. Bodies of this kind are termed solid; those in which the molecular force opposes a change of volume only, are termed fluid. Since the resistance of bodies to a change of form may be very small, solid bodies gradually pass into fluids.

Those fluid bodies which occur only in a compressed condition, and are consequently always striving to enlarge their volume, are named airs or gases. The other fluid bodies which have a determinate volume, and have no tendency of themselves to enlarge it, are termed liquids.

These three several conditions of matter—solid, liquid, and gaseous—are termed the aggregate conditions of bodies.

In solid bodies, the molecular force resists all change both of form and volume. This resistance may be a function of that change, and is null between certain limits, when the change of form and volume is null. These limits are termed the limits of the elasticity of the body, and the body within these limits is termed elastic. Within the limits of elasticity, the equilibrium of the molecules is stable; that is, they return to their original condition when the force causing the change is removed. But when these limits are exceeded, the molecules assume a new position of equilibrium, and every separation of a body into parts must be thus regarded.

When a body is heated, the repulsive molecular force is thereby increased; therefore, if there is no exterior obstacle, the molecules will not find their equilibrium, until a greater distance is interposed between them, and an expansion of the body will consequently take place. But when the temperature of a body falls, the repulsive molecular force being thereby lessened, the body contracts. In order to explain the phenomena of contraction and expansion, which accompany the presence or absence of heat, it was formerly supposed that a subtle, imponderable matter, surrounded each of the molecules of a body like an atmosphere, which matter itself contained all the repulsive energy. It was supposed that attraction existed not only between each of the molecules of the body, but also between these molecules and the matter termed caloric, and it was then supposed that the particles of caloric repelled each other. This hypothesis, however, has been latterly abandoned, since it explains only a few of the phenomena of heat.

As an increase or decrease of the heat of bodies effects a corresponding change of volume, the expansion or dilatation of a body, howsoever effected, produces inversely a decrease of its heat, and its compression or condensation causes an increase of the heat. In the former case, the body seeks to replace the heat lost, by obtaining it from surrounding warmer bodies. In the latter case, the body communicates to them the overplus of its own heat.

The operation of heat not only consists in increasing the repulsive force of the molecules, but the formative force is altered also. In solid bodies that force is diminished by increasing the heat, so that at length it entirely disappears, and the body passes from the solid into the liquid state—that is, it dissolves. By a sufficient diminution of heat, liquid bodies acquire the formative force, which they previously wanted, and become solid—that is, they become rigid; while, on the contrary, by an increase of heat, they pass after a while into the state of gas—that is, they evaporate. There are reasons to suppose that every body may assume each of the three aggregate conditions, by sufficiently increasing or diminishing its heat.

As long as the aggregate condition of a body remains unchanged, and consequently an increase or diminution of the heat of the body occasions simply a corresponding change in the repulsive force of the molecules, its heat seeks to diffuse itself amongst such surrounding bodies as are colder. By these means it becomes sensible to the feelings, and affects the thermometer; hence it is named sensible heat. On the other hand, when the aggregate condition of a body is changed by the heat, and the body passes from the solid into the liquid state, or from that into the state of gas, a certain quantity of heat is combined by this change with the body, so that it cannot be communicated to adjacent bodies, and consequently is unable to act on the senses or the thermometer: this heat is termed combined or latent heat. The same thing happens when the alteration of the aggregate condition is induced by any other cause, and the temperature of the body then falls, because a part of its heat is combined and rendered latent; when, on the contrary, a body passes from the liquid state into the solid, or from gas into liquid, a part of the heat formerly combined is set free, and becomes sensible, and the temperature of the body increases if the heat is not absorbed by the colder bodies near it.

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RECENT PATENTS.

STEAM-ENGINES AND BOILERS, AND THE PREVENTION OF ACCIDENTS IN WORKING THE SAME.

R. Wilson, *Low Moor, Yorkshire. Engineer.—Enrolled, May* 21, 1850.

Mr. Wilson, well known for his improvements in the steam hammer, and various other important inventions, has described, in this specification, seven heads of modifications and additions to steam machinery, possessing many features of great value. As we propose to illustrate the details on a future opportunity, we shall, for the present, merely give a general enumeration of the several contrivances. These are—

1st, An arrangement for the prevention of boiler explosions by the application of a water-column pipe, like the ordinary low-pressure feed-pipe, so that, when the water-column is raised in this pipe to an undue height by an accidental increase in the steam pressure, a discharge of water into the furnace occurs, and thus wholly or partially extinguishes the fire. The same apparatus is also made available for the prevention of accidents arising from a want of water in the boiler, so that, when the water level falls below the lowest level of safety, a current of steam passes out by the water-pipe, and is discharged into the furnace for the purpose of suspending the further generation of steam.

2nd, A peculiar construction of steam-engine pistons, by the adoption of adjustable wedges placed between and behind the packing-rings; as also a novel arrangement of the packing-rings.

3rd, A peculiar construction of pistons or buckets for air and water-pumps of steam-engines, namely, with packing-rings, with bevelled or inclined edges, by which they are retained against the surface of the cylinder, without the aid of springs or other means. This is effected by forming the packing-ring in several segments, having their edges bevelled. The upper edge is considerably inclined, so that the weight or the pressure upon a solid ring, resting on the top of the segments, forces the latter outwards against the cylinder, by means of a corresponding inclined lower edge.

4th, The regulation of the velocity of steam-engines by means of the ordinary pendulous governor, contrived to effect two movements; the one in connection with the regulator or throttle-valve, and the other with the expansion apparatus.

5th, The application to expansion-valves of a piston or plunger, for effecting the movement of the valve in one direction by the pressure of the steam, whilst the usual actuating apparatus gives the reverse movement.

6th, An arrangement for working the valve-gearing by a combination of levers, for giving a differential movement to the valve, or a quick and slow motion at certain parts of the stroke.

7th, A disengaging link apparatus for steam-engine valve-gearing, by means of which, upon the disengagement of the eccentric rod, the slide-valves will be caused to cover the ports or passages to the cylinder, for the purpose of stopping the movement of the engine in case of accident.

In a future part, we shall give a full account of the action of these very ingenious and beautiful contrivances.

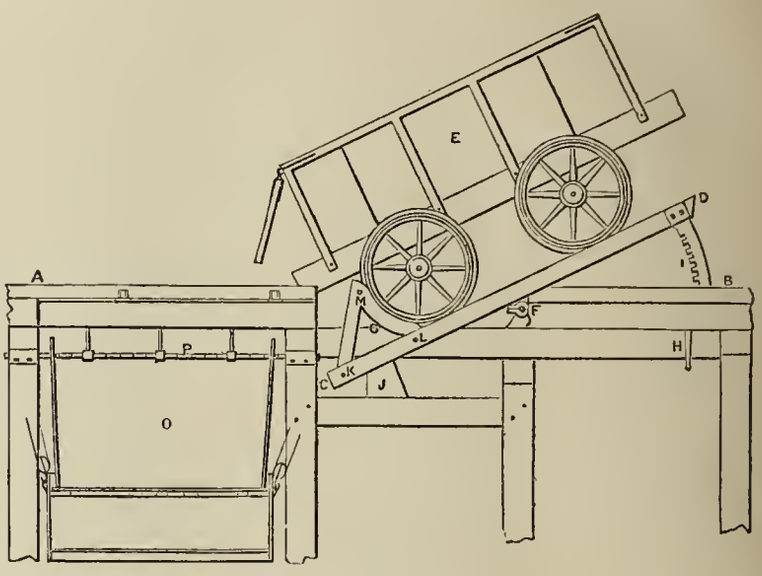
REGISTERED DESIGNS.

MINERAL DISCHARGER.

Registered for Mr. W. Robertson, *Civil Engineer, Glasgow.*

The ordinary railway discharging apparatus for minerals, can only be fitted to the end of a line of rails—the tipping action being performed so as to discharge the loads from the waggons in the line of the direction of the rails. In this clever arrangement, the apparatus may be fitted up for discharge at any point of the line, and is not necessarily confined to termini formed on purpose. The engraving, fig. 1, represents a side elevation of the discharger, with a waggon thereon, in the act of tipping; and fig. 2 is a longitudinal section of the line where the discharger is fixed, showing the tipping-frame in its place, for the passage of traffic. A B, Is the line of rails; a length of which—sufficient to carry a waggon—is cut away at from C to D, the space being filled up when the line is in a condition for the passage of traffic, by the two lengths of rail, C D, bolted together transversely, and forming a frame to receive the waggon, E. This frame is capable of oscillating, or partially turning, on the centre, F.

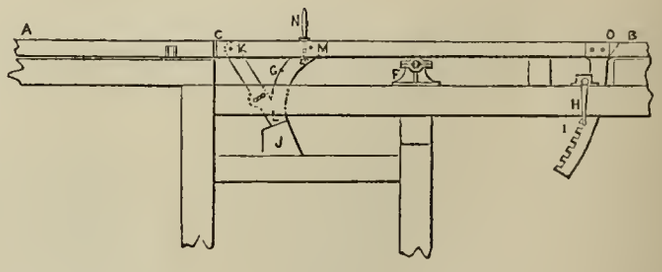
Fig. 1.



1-72d.

When the waggon is run upon the rails, C D, with its wheels up against the stops, G, it is elevated to the tipping angle, as in fig. 1, by the winch-handle, H, working a toothed pinion in gear with the curved rack, I, on the end, D, of the frame. The end, C, being depressed, comes

Fig. 2.



1-72d.

down upon a block at J, where it rests during the discharge of the coal. The stops, O, are pinned to both rails by a joint-bolt at K, and the other two angles, L and M, have pin-holes for securing them, either as represented in fig. 1, as a stop for the wheels, or as in fig. 2, to form a support for the frame upon the block, J, when the frame fills up the opening in the line. The adjusting pins are worked by a lever, N, which stands upright when the pins are withdrawn, showing that the line is not then secured for the passage of waggons. When the lever is pressed down, it inserts the pins both in the rails and stops. The coal is discharged into a malleable iron spout, formed in three divisions—the upper one of which, O, turns on a centre at P, at right angles to the line of rails, which are supposed to run parallel with the line of pier, over which the minerals are to be discharged into boats beneath. The second piece is jointed to the bottom of the first one; the two being adjustable to the level of the boat by means of blocks. At low water, when the boat is far down, a third piece is employed, which, when out of use, is made to slide in beneath the second division, the side-pieces which guide the coal being moveable, so as to take in and out. The advantage of the plan is, that it may be conveniently put down at any point in a line of railway, whilst the rails at the part are easily adjustable for passing traffic. The arrangement of the stops, G, whereby they are made to serve a double purpose, is particularly ingenious.

WEIGHTING AND DRIVING APPARATUS FOR THE ROLLERS OF WOOL-WASHING AND CALENDERING MACHINES.

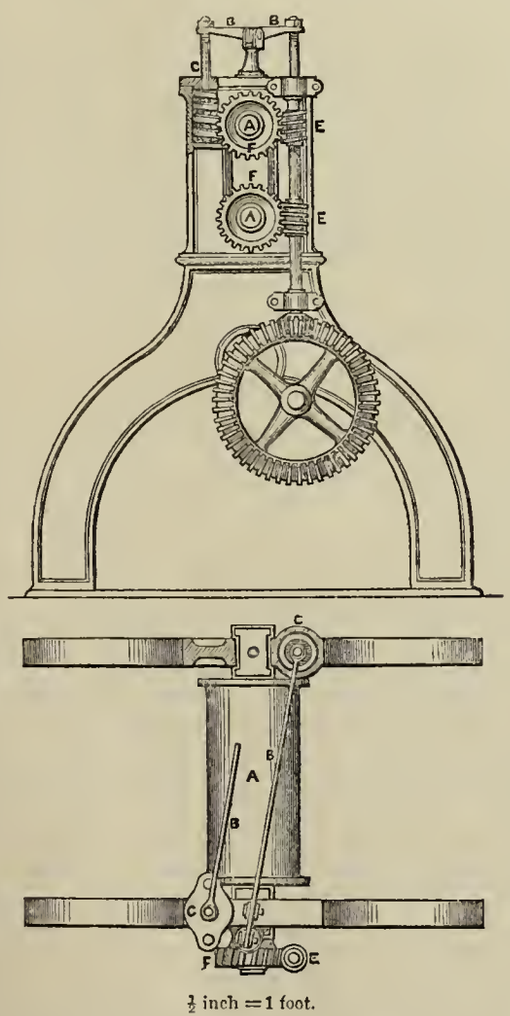
Registered for F. Wilson, Esq., *Leeds.*

In the machinery coming within the category of those to which the title of the present article makes reference, the requisite pressure on the rollers is obtained by hanging a weight on the end of a powerful lever, whilst one roller only is driven directly by gearing, the other being turned by the frictional contact of its neighbour. In Mr. Wilson's contrivance, both rollers are driven from the prime mover by means of worms and worm-wheels, and the two are made to travel at different speeds, in order to produce a more effective action on the material passing through. This differential movement has been repeatedly tried before with ordinary gearing; but the occasional rising of the upper roller is, in such case, very objectionable, owing to the teeth of the connecting pinions of the two roller-shafts being so apt to get out of gear.

The present plan provides for this in such a way as to keep the pinion or worm-wheel on the upper roller constantly in gear with its driver, whatever may be the amount of vertical rise.

Our engravings represent, in fig. 1, a side elevation of a machine, with the driving apparatus applied to it; and in fig. 2, a corresponding plan, both views being partially sectioned. The pair of rollers, A A, are here pressed together by spring levers, B B, ingeniously arranged, so as to offer no inconvenience in working the machine, being passed transversely across the framing, and at a slight angle with the line of rollers. Their fulcra and points of resistance are reversed; the journal pressure ends being on the sides of the framing, opposite to their holding-down springs, which are hid in boxes at C C. The vertical shaft, D, driven by the bevel gear below, gives motion to both rollers by the right and left worm-wheels, E E, gearing with the worm-wheels, F F, on the roller-shafts. Thus, where any rise of the upper roller takes place, the worm-wheel on its shaft merely rises a little higher up, so as to work a little nearer; the top of its worm still remaining in perfect gear with it.

Fig. 1.



½ inch = 1 foot.

The contrivance will be of some importance in bleach-works, in machines for drying the yarn. For such purposes a great pressure—from 12 to 15 tons—is required, and this is only clumsily attained by the ordinary weighted lever.

RADIATING REGISTER GRATE.

Registered for Mr. John Finlay, *Ironmonger, Buchanan Street, Glasgow.*

We have had so many impracticable schemes for grates and stoves, whose only recommendation has consisted either in their novelty, or in the monstrosity of their names, that we feel considerable pleasure in directing attention to what is at once a philosophical improvement upon, and an addition in point of elegance to, the modern fire-grate. In Mr. Finlay's "Radiating Register Grate," the inventor has been successful in satisfying both these conditions; for it comprises an increased efficiency in the draught and the radiation of heat, with a simplification of the details of the regulating door and cheeks at the sides and back of the grate, where the throat of the chimney commences, involving also a superior degree of cleanliness.

Fig. 1

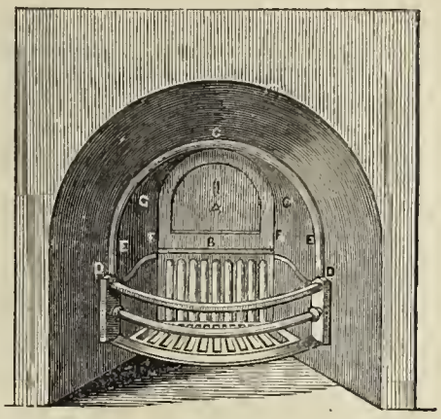
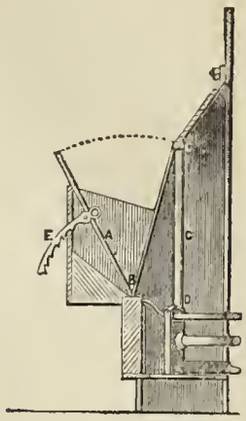


Fig 2



1-24th size.

Fig. 1 of our engravings is a front elevation of the grate, with the ash-pan and fender removed; and fig. 2 is a vertical transverse section through the grate and draught-door. Instead of forming the draught-door in two parts, a single overhanging door only, as at A, is employed in the present arrangement. This door turns upon a centre at B, and is represented as closed in fig. 1, and open in fig. 2. It is prolonged upwards, in order that, when shut, its upper rounded end shall join up to the top of the head, C. The latter is formed, and brought out so, that its two ends, D D, shall coincide with the end pieces of the bars, adding much to the appearance of the grate.

The door, A, may be set at any suitable angle of opening, which may be more or less, according to the depth of the fire, with its upper end overhanging forward. The spaces between the inner edges of the bead, as at E E, and the sides, F F, of the draught-door, are filled up with the cheeks, G G.

The drawings furnish the best evidence of the elegance of the contrivance, and a little consideration will show that the single overhanging door is practically a great improvement upon the old plan, where a portion of the inclined front of the grate is hinged also.

REVIEWS OF NEW BOOKS.

An Essay on the Present and Future Prospects of Farming in Great Britain. By W Thorold, M. Inst. C.E. London: Ridgway, 1849. Pp. 24.

This is a stirring little pamphlet, by a man who has been well trained in the two schools of agriculture and engineering. To many of our readers, Mr. Thorold, as a member of the Institute of Civil Engineers, will be no stranger, but it may not be so well known that he was originally a Norfolk farmer. We have always striven, as opportunity occurred, to show that we most zealously endeavour to advance the mechanism of agriculture, and to elevate our farming practice to the character of a sound practical science. We have, then, no little pleasure in meeting with so stout an advocate of our views as Mr. Thorold, whose views, whilst they point in a truly scientific direction, are yet not too far in advance of the age to preclude their general introduction. He insists strongly upon such an arrangement of farms as shall bring them into the most compact form; and in this respect, we doubt not but he will meet with plenty of instances where he may reasonably urge his point. His strictures on farm buildings are accompanied by a sectional elevation and plan of a model arrangement, wherein he has studied all the important features of improvement to which the farmer will be finally driven, under the various influences which are now more than ever affecting him. Although we cannot present a copy of the plan itself, we may yet extract the author's description of it:—

"The object of this design is to convert all the straw, hay, and green crops into manure, and to retain or prevent the loss of such manure after it is obtained, in the most effectual and economical manner: it is applicable to any sized farm, by merely increasing or diminishing the feeding and storing departments; but in all cases it should be limited to farms not exceeding a convenient length or breadth from the homestall, on account of the expense of road-making and carriage. Steam power is intended to be applied to thrashing, dressing, grinding, and bruising corn, steaming food, cutting hay and straw into chaff, pumping water and liquid manure, slicing turnips, breaking oil-cake, sawing wood, raising manure from the house by an inclined plane, to load the carts

instantly, and prevent the horses waiting for the same; and probably for the purpose of exhausting foul air from the feeding-houses, to excite hunger in cattle, and thereby diminish the time of fatting. It is here necessary to inform our readers, that this last plan has been adopted in factories as a principle of ventilation, and the only objection to it has been, that it makes the workpeople always hungry, the very thing of all others beneficial in grazing or fatting cattle. Provision should also be made for rendering the feeding-houses perfectly dark for an hour or so after feeding time, in order that the cattle may take their rest. Crammiug may thus be introduced into cattle feeding, as has long been practised with Ortolans poultry.

"For this purpose a portable steam-engine is preferred (with fixed barn machinery, &c.), on account of its being applicable to more than one set of buildings, which will render it less expensive, and also more adapted to meet the possible contingency of steam ploughing, and being sent to the factory to be repaired, thus avoiding the nuisance of having mechanics on their premises, or it can further be supplied by a travelling or club engine.—1. The corn barn is open at each end, with a railway running through it, upon which stacks are to be built upon staddle-frames running upon wheels, instead of standing as heretofore upon fixed piers or pedestals, and as many staddles are to be provided as the probable number of stacks. A stack is to be built on these staddle-frames, upon any part of the railway, and can be run into the barn at night, and remain there under cover until it is thatched, which it is obvious can be done either in wet or dry weather. As soon as it is thatched, it is to be run through the barn, a sufficient distance out of the way, and another staddle-frame is to be brought empty from the cross line, and a stack built thereon as before. As soon as it is ascertained that the barn will contain the remainder of the crop, it can be filled in the usual way, and of course this last must be thrashed out first; afterwards the stacks on the staddles can be introduced into the barn, and thrashed by a like process. The length of railway will be limited by the locality and expense, but it must be of sufficient length to admit of two or more kinds of corn being stationed on either side, so that any particular stack can be thrashed when wanted, by running all those before out of the way; as it is intended to have the rails perfectly level, but little power will be required to do this. Hay stacks may also be stationed on close-boarded staddles at one end of the line, and can afterwards be brought into the barn when they are required to feed the hay-cutter, being thus under cover during the time it would otherwise be partially exposed to the weather.

"When the stacks are only required to be moved a short distance, it can be done by a windlass and manual power, or by a capstan driven by the engine, as now practised at the Royal Arsenal in hauling timbers from any part of the yard to the saw-mill. As soon as a stack is thrashed, the staddle can be run over the centre of the cross line, and by means of a screw, with a capstan-head raised above the line of rails, and being nearly an equal balance, it can be turned by two men, and lowered into the cross line; it is then to be covered with a sufficient quantity of wheat straw, to keep off the weather, and out of the way on the cross line, such straw being applied in thatching the ensuing year's stacks, and ready when wanted.—2. The house to contain the portable steam-engine, to be connected through the wall by a universal joint to the driving-shaft of the permanent machinery, and also by a swan-neck joint to the pipe feeding the steam cookery.—3. The thrashing drum upon the upper floor.—4. Straw-shaker.—5. A Jacob's ladder, whose duty it is to remove the straw from the shaker into the straw barn.—6. Where it remains until it is wanted for litter or other purposes; if required to be be cut, it can be brought back again by reversing the motion of the ladder. It is presumed every grain of corn will thus be separated from the straw, and the straw will be in the most convenient place for its future application; being connected with the feeding houses and stables, it can be got at with the least labour, and perfectly dry and clean.—7. The steam cookery; it will also be desirable to place the manure and cold water pumps here to keep them from the frost.—8. Hay and stray and straw-cutting house.—9. Corn-bruising and cake-breaking mill.—10. Turnip-slicing house.—11, 11, and 11, are feeding stalls for thirty beasts.—12. Stalls for ten milch or grazing cows.—13, 13. Stables for eight cart horses.—14, 14. Harness rooms.—15 and 16. Chaff bins.—17 and 17. Manure or dung house.—18. Liquid manure tank, under part of ditto.—19. House for a bull.—20. Infirmary for sick cattle.—21. Stalls for six suckling or milch cows.—22. Pens for rearing calves.—23. Turnip house.—24. Fuel, &c. &c.—25. Lodge for yearling stock.—26. Saddle-horse stable.—27. Sow and pigs.—28. Fat pigs.—29. Turnip or root house.—30. Oil-cake or meal store.—31 and 31. Cart lodge.—32. Granary for horse corn.—33. Parlour or clerk's office.—34. Kitchen or bailiff's room.—35. Wash-house.—36. Dairy.—37. Dormitory for casual labourers or servants.—38. Railway.—39. Cross or light railway.—40. End view of corn stack in barn under cover.—41. Inclined planes for manure loading, as before alluded to.—42. Court or farm yards.

"It is presumed these buildings are concentrated in a sufficient manner to save materials in their original construction—to avoid unnecessary shafting in connecting the machinery, and thereby economise power in the engine, so as to reduce the under-ground drainage to the shortest possible distance, and all manual operations and inspection to the minimum, with a great provision for manual labour being performed under cover in wet weather. There is no greater room allowed for the several appropriations than has hitherto been considered indispensable under any common plan, and from the character of the buildings they need not be expensive; and to avoid this in one point, it is not intended to dress the corn coincidently with its being thrashed, but the day after, several other trifling advantages being obvious."*

To bear up against the results of free trade, the agriculturist must not scruple to condemn the more destructive species of game; and his timber and hedge-rows, however ornamental in the eyes of the mere looker-on, must give way to the utter necessity of economising every inch of ground.

The author quotes a recent remark of a Scotchman, which is so apposite to the purpose, that we shall assist in its further dissemination by closing these remarks with it:—

"Capital will not make a successful farmer, unless it be combined with *skill*, *capacity*, and *experience* in its possessor. *Skill* to execute with economy and advantage the necessary improvements and operations; *capacity* to foresee and direct these operations in the channel most likely to be remunerative; and *experience* to manage with delicacy and precision the difficulties, whether in stock or crop, which constantly demand the attention of the practical farmer."

* "For this last suggestion the author has been charged with being behind the age!!"

CORRESPONDENCE.

STEAM-ENGINE ECONOMY

As one great object of the *Practical Mechanic's Journal* is the recording of facts in science and art, may I solicit for myself a corner in its pages, for the purpose of making known some economical arrangements which I made upon a steam-engine in the fall of 1847? The engine in question is a low-pressure condensing beam, with slide valves of the ordinary D kind; diameter of cylinder, 26 inches; stroke, 5 feet. It has two steam-chests—one at each end of the cylinder, connected by a pair of columns, one of which acts as the steam-pipe, whilst the other contains the exhaust passage; the whole exterior having the appearance of a piece of architecture of the Tuscan order. The D valves are made and packed in the usual manner, and the state in which I found them was as under:—

Width of ports,	$3\frac{1}{2}$ inches.
Length of ports,	$11\frac{1}{2}$ "
Breadth of valve faces,	$3\frac{3}{4}$ "
Cover on steam side,	$\frac{3}{8}$ "
Exhaust being $\frac{1}{8}$ inch uncovered.	
Stroke of valves,	$8\frac{1}{4}$ "

The alteration upon them I effected by the addition of a piece of brass to the steam side of each valve, with a change in the length of their connecting rod, and they are now in the following condition:—

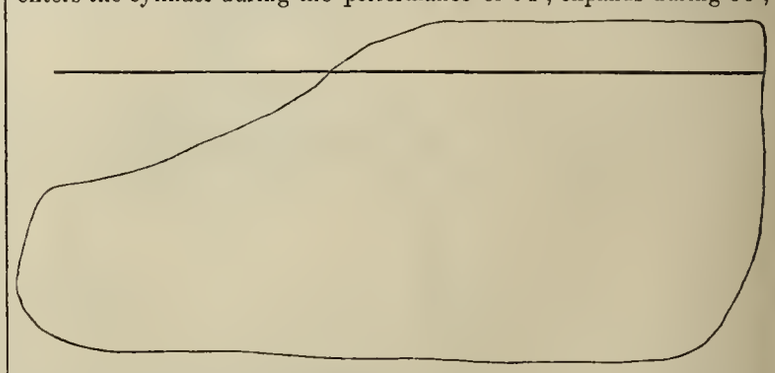
Breadth of faces,	7 inches.
Cover on steam side,	$2\frac{3}{4}$ "
Cover on exhaust,	$\frac{3}{4}$ "
Lead,	$\frac{1}{8}$ "

The state of the valves at the extremity of their stroke, is—

Bottom edge, opening on steam side,	$1\frac{3}{16}$ inches.
" " exhaust,	$3\frac{3}{16}$ "
Upper edge, opening on steam side,	$1\frac{5}{16}$ "
" " exhaust,	$3\frac{5}{16}$ "

The difference of opening on the opposite sides, arises from the angles formed by the connections. With this arrangement, the valve cuts off the steam at three inches past the half stroke of the piston, and the expansion continues from this point up to four inches from the termination of the stroke; and at this time the exhaust port is two inches open.

On the return stroke the valve closes the exhaust. When the piston is 11 inches from the end of the stroke, at the bottom of the cylinder, the piston has a clearance of $1\frac{1}{8}$ inches, and at the top $1\frac{1}{2}$ inches. Supposing the semi-revolution of the crank to be divided into 180°, steam enters the cylinder during the performance of 94°, expands during 56°,



and throughout the remaining 30°, the steam is open from the cylinder to the condenser, so that the steam has allotted to it about one-third the time to rush out, that it has to rush into the cylinder.

The annexed diagram was taken from the cylinder after the alteration, when in the regular course of duty. It is clear evidence of the correct action of the valves, and must be considered in connection with the fact, that the expansion is entirely accomplished by the ordinary slide-valve, with a face on the steam-chest rather bad than otherwise.

The boiler pressure was 3 lbs., the diagram showing $2\frac{1}{2}$ lbs. with a vacuum of 13 lbs., the speed of the piston being 290 feet per minute. In the *Practical Mechanic and Engineer's Magazine*, vol. iv., 1845, you will remember I advocated the adoption of increased speeds in conjunction with high expansion, and I think the case before us is a tolerable exposition of the truth of my views. When the engine was first set to work, it was calculated for the old rate of 220 feet, but it has been shown that it might even run much faster than its present rate of 290 feet. Previous to the alterations I have described, complaints were made of the occurrence of shocks on turning the centres. Now, nothing of this sort ever takes place, although the valve faces are perfectly parallel on the edges, and open the ports directly across at once.

Some engineers are in the habit of putting *curved* lap-pieces on the steam side of the valves, in order to wiredraw the steam on its first entering the cylinder, so as to avoid the shock, or soften the action, of the entering steam upon the piston. Now the best examples of modern stationary engines get their steam instantaneously by means of conical, equilibrium, and many other kinds of valves; and I am led to believe, from my own actual experience, that the slide-valve, with the usual straight outline, is already sufficiently defective as a wiredrawing valve, without making it still more so by these shifts. It has been stated that

the curve has been introduced to avoid *flushing*—that is, an unsteady foot-lathe-like motion, experienced when expansion is carried too far. This objectionable action, which is most injurious in spinning establishments, is, I suspect, rather to be traced to the sluggish movement of the piston—an allegation which, until very lately, few engineers would admit.

The fact of the closing of the eduction port when the piston is 11 inches from the end of its stroke, in the engine to which reference has been made, may perhaps be termed an unavoidable evil. Unavoidable it is, but how far the evil goes remains to be seen. The diagram shows that the pent-up steam does not reach the atmospheric pressure, there being the clearance and ports to fill. On the other hand, whatever shutting-up action does occur, would appear only to effect the smoothing of the reverse motion of the engine. In starting the engine, much difficulty is experienced in getting over the first centre, owing to the lap on the steam side, and the two-inch lead on the exhaust; but once over, if the vacuum is tolerable, there is no more trouble.

The Boiler.—The boiler is of the common waggon shape, 21 feet long, with an internal flue. The heat, after traversing the bottom, returns along the internal flue, splits in front, and passes back again along both sides of the boiler, finally entering by the damper into the chimney. The heating surface is made up as follows:—Bottom of boiler directly exposed to the action of the fire, 27·5 square feet; bottom behind the bridge, acted on by carried heat, 88 feet; central flue, 149·1 feet; side flues, 168 feet; front end, exposed to carried heat, 13 feet; back ditto, 5 feet: total, 450·6 feet. The length of the heat's travel is 63 feet; originally, the furnace bars were 18 inches below the highest part of the boiler bottom, and the furnace projected so far forward, that the first 3 feet of the boiler appeared to get the greatest radiating heat from the incandescent fuel. Retaining the original area of furnace, it was led back 22 inches farther under the boiler, lowering also the furnace bars to the depth of 12 inches, so that their level was made 2 feet 6 inches below the boiler. In this re-arrangement, every part of the furnace is covered by the boiler, the frame of the furnace-door being built in below the angle iron of the boiler end, so that the door, when closed, stands in a line with the boiler end. The present dimensions of the furnace now are—Length of bar surface, 5 feet; breadth, 4·3 feet; making an area of 21·5 square feet. Its mean height being 2 feet, its capacity is equal to 43 feet.

The space under the boiler, from the furnace backwards, was made of considerable capacity, and the bridge was built up in every part to 4 inches from the boiler bottom. The area of the throttling-place is about one-fourth that of the internal flue, so that the current passes this part at its highest rate of velocity. The use of this throttling action, I may here shortly discuss.

The fire is kept as thin as possible, and generally, notwithstanding the attention of the fireman, a quantity of air must always pass through the grate, without a chance of combination with the incandescent fuel; and in addition, the heat continually sets free the volatile gases of the fuel. Much of the carbon also passes away as carbonic oxide. This waste goes on to its fullest extent, when there is a tolerably thick bed of half-burnt fuel on the bars. Without the application of some remedial agent, each product would get away in its independent state, but the throat answers the purpose of forcing together and mingling the gases, turning the whole mass to account.

The bridge is always at a great heat; and at periods when there is little smoke distilling, the action of the fire upon it raises its temperature to the maximum, and when a fresh charge of fuel is applied, this heat is to a considerable extent liberated, and taken up by the smoke and passing vapour. The heat, thus partly acquired from the bridge, renders the vapour fitter for combination, and the object of the large space behind the bridge is to allow room, so that the current may pass away at a slower rate.

As respects the quantity of air to be admitted to the furnace, if the fire is kept very thin, the necessary quantity will always find its way through; but if at any time too little should be thought to be passing through, a remedy is easily provided, in leaving a portion of the bars uncovered. With such an arrangement, coupled with moderate attention on the part of the fireman, it is possible to prevent the escape of visible smoke; but the avoidance of all smoke does not, in this plan, act so economically, as when a little smoke escapes at charging or stirring the fire.

I had no means of accurately measuring the quantity of water evaporated by a given quantity of fuel, so as to give the economical value of the boiler; and no one is justified in condemning any form, or setting of the boiler, before its evaporative powers are ascertained. I cannot help condemning the practice of estimating the qualities of engines by the pounds of coal consumed per horse-power per hour. The question should be—how many cubic feet of water, at a given temperature, does one ton of a certain fuel evaporate from the boiler, and in what time? And for the engine—how many pounds are raised one foot high, by each cubic foot of water evaporated? at what initial pressure does the steam enter the cylinder? and at what point is it cut off?

Some method of this kind will keep separate the merits or demerits of the engine and boiler, and a fair estimate may be made of the qualities of each. In the example I have given, the modifications on each were effected at the same period; and the result is, that 26 cwt. of fuel now goes as far as 39 cwt. did before.

To effect the perfect combustion of the gases derived from coal, it appears to me that the following points should be attended to:—

1st, That abundance of air be admitted amongst the burning fuel.

2nd, That the air be caused to enter the furnace to *some extent*, without passing through the incandescent fuel.

3rd, That the air and gases be prevented from losing heat, before the atoms of gas and oxygen from the air have had time to combine chemically.

4th, That, to obtain the last desideratum, the products of combustion should for some time be shielded from the cooling action of the boiler.

5th, That, to effect this, it appears to be necessary to form a large space behind the furnace-bridge; in fact, a space of a sectional area equal to that of the boiler, the flame to enter this space near the bottom, and the said space to be enclosed with brickwork, to prevent radiation.

6th, That the boiler be made conical, like a sugar-loaf; the side next the ground to be set horizontally, or even to dip somewhat towards the small end; with such a contrivance, the steam would not reach far back in the boiler, and with the cold water introduced at its small end, it would not instantaneously rob the warmer portion of the water of its heat.

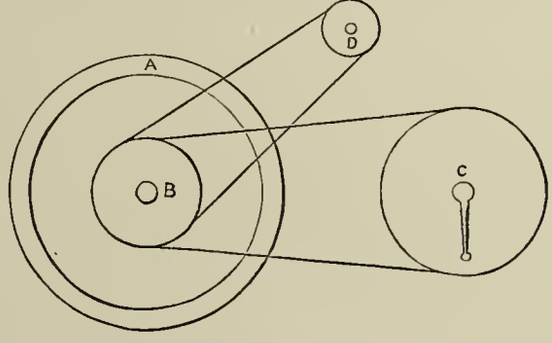
The fire is supposed to be at the large end, as also the steam-chamber. No return flue is required, as the boiler is presumed to be made long enough without it. This boiler would have the greatest heat of furnace where the hottest water is required, and as the products of combustion pass onwards to the small end of the boiler, they diminish in heat, and in like manner the boiler will diminish in heat, until, at the small end of the boiler, the heat will be about the same as that of the injected water. Here, then, is a most simple arrangement for robbing the products of combustion of their last particle of heat. The taper of the boiler may run out as small as it is possible to make it, or keep it clean, and its length is indefinite.

ROBERT DEMPSTER.

Blairgowrie, May, 1850.

GEARING FOR HAND-DRIVEN MACHINERY.

I have a quantity of machinery driven by hand labour, applied to a winch-handle, and should be glad to learn if any of your correspondents can afford me information on the best arrangement for the purpose.



I have a fly-wheel, A, 5 feet diameter, weighing 4 cwt., running on a second motion shaft, carrying a pulley, B, 2 feet diameter, driven from a 3 feet pulley, C, on the first motion shaft, which is worked by the winch handle, as in the sketch. The speeds are thus as 3 to 2. I do not require a very quick speed for the horizontal shaft, D, carrying a 12 inch pulley,—say 40 revolutions per minute.

I should be glad to know of any better arrangement than this; also the rate at which the fly-wheel should run to give out its best effect, and if belts or gearing would run easiest. Information on these points may be of service in this town, as we have a good deal of hand-turning here.

J. D.

Macclesfield, May, 1850.

ON THE COMPRESSION AND EXTENSION OF IRON.

Templeton, in his 'Workshop Companion,' page 98, gives rules for columns thus, $\frac{P \times L^2}{L} = D^4$ — P. pressure, L. length, D. diameter. I have tried to apply this rule to piston-rods, connecting-rods, and side-rods, but cannot make a rule that will agree with practice. Turnbull

on Iron, gives the elastic tension of a square bar of wrought-iron = 17,800. Now, what length must a wrought-iron rod 1 inch diameter he, to he compressed to the extent of its elasticity? Suppose I take a connecting-rod, 10 feet long, and loaded with 12,000 lbs., the diameter at the ends would he 2 inches; hut what should the middle he hy rule, and not hy guess? Messrs. Fairhairn's engines in the *Odin* have very short connecting-rods, and I conceive they have no need to be swelled in the middle, heing strongest in the thrust, even if they were parallel. As wrought-iron framing is getting into general use, it is very neeessary that we should know how to apply it with the most economy, hesides avoiding the extra weight. The question may he hetter asked thus:—What length will a rod 1 inch diameter be, to be strained to its elastic limit, cast as well as wrought-iron?

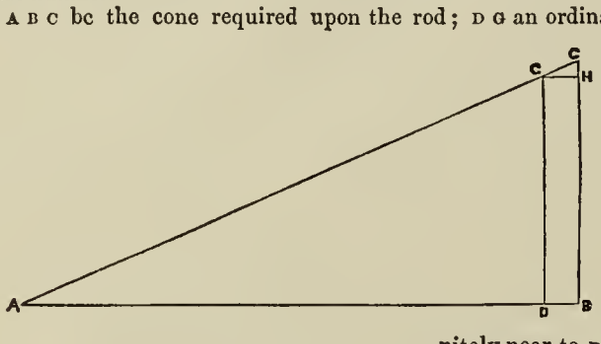
R. B.

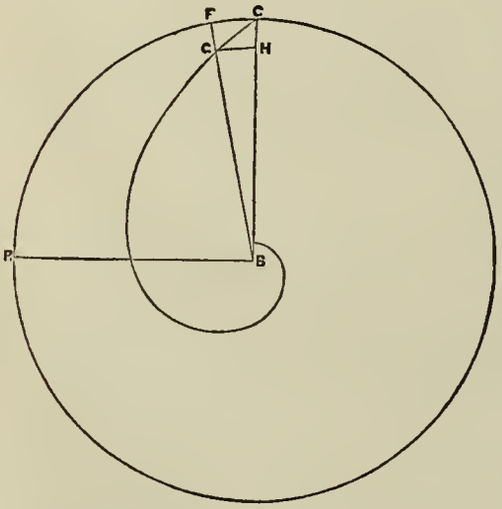
Lincoln, May, 1850.

DIFFERENTIAL SLIDE-MOTION FOR LATHES.

With your permission, I beg to offer the following solution to the question on the differential motion for slide-lathes, proposed by me in your last number.

Let A B C be the cone required upon the rod; D G an ordinate infinitely near to B C. Put A B=a, B C=b, G H=x, and C H=y. By similar triangles, we have $a : b :: x : y$ $\therefore x = \frac{ay}{b}$; whose differential is $dx = \frac{ady}{b}$.





Also in the spiral, conceive the ordinate, F B, infinitely near to B C; and put B C=b, G H=x, B G=y, F C=z. By the parellels, $b : z :: y : x$ $\therefore x = \frac{yz}{b}$ differentiate, we get $dx = \frac{ydz}{b}$; equating this value of dx with the former, we have $ydz = ady$, or $dz = \frac{ady}{y}$; whose integral is z=log. y, an equation of the logarithmic spiral. Therefore, to any portion of the arch, R F, B G must he its corresponding logarithm.

For the segment of a circle, we have the general equation, $2ax - x^2 = y^2$; whose differential is $2adx - 2xdx = 2ydy$ $\therefore dx = \frac{ydy}{a-x} = \frac{ydy}{\sqrt{(a^2-y^2)}}$. Comparing this with the value of dx in the spiral, we derive $dz = \frac{bdy}{\sqrt{(a^2-y^2)}}$; whose integral is a circular arch of radius a, and sine y, or to any portion of the arch R F. $BG = y + \frac{y^3}{2.3a^2} + \frac{3y^5}{2.4.5a^4} + \frac{15y^7}{2.4.6.7a^6}$ + &c. For the parabolic curve we have the equation $ax = y^2$; whose differential is $adx = 2ydy$, or $dx = \frac{2ydy}{a}$. Equating as before, we get $\frac{2ydy}{a} = \frac{ydz}{b}$ $\therefore adz = 2bdy$; whose integral $az = 2yb$. Hence $y = \frac{az}{2b}$; an equation of Archimedes' spiral. For the logarithmic curve, we have the general equation $ydx = mdy$, or $dx = \frac{mdy}{y} = \frac{ydz}{b}$ $\therefore dz = \frac{mbdy}{y^2}$; whose original function is $z = -\frac{mb}{y}$; the equation of the spiral that will produce the logarithmic curve upon the barrel of the rod.

In a similar manner we may find the equations of spirals that will produce any geometrical figure in the lathe, merely by finding the value of dx in the equation of the given curve, and equating it with the value of dx in the spiral, the integral of which will show the ratio the ordinates of the spiral must have to any corresponding portion of the generating circle.

An elegant method of producing a *tidy-shaped rod*, has been employed hy Mr. James Mann of this town, upwards of eleven years, by the following simple process (see the illustration at page 42 of this Journal for May):—

Conceive a cord to he wound round the circumference of the spiral, A C, the end of which is secured at the point, C, independent of the spiral; then, hy the longitudinal traverse of the slide, the spiral will of course unwind itself, and regulate the screw of the slide-rest aecording to its construction.

Robert Muckelt.

Crewe, 7th May, 1850.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

April 9.

William Cubitt, Esq., President, in the Chair.

"On the Construction of Locks and Keys." By Mr. J. Chubb.

The author commenced by stating that the most ancient lock, of whose form and construction there was any certain knowledge, was the Egyptian, which had been in use for upwards of four thousand years. The construction of this lock was minutely described, also that of the ancient "warded" and "letter" locks, and considerable antiquarian research was displayed in tracing their origin and introduction. These three kinds of locks were, in principle, the foundation of all modern locks, which might be thus enumerated,—reversed, for obvious reasons, in the order of their antiquity:—

First,—The letter locks; mostly used for padlocks, and were so far convenient, as a key was not required for opening them. A modification of this lock had been proposed, called the "scutcheon" lock, for securing doors and iron safes, but it was too expensive and complicated to come into general use.

Second,—Locks having fixed wards, in which no real improvement had been made in modern times. These locks were bad in principle, as they could be easily picked; and owing to many thousands of them being yearly made that could be passed by the same key, little or no security was afforded by them; in fact, it might be safely asserted, that twenty skeleton keys would open all the locks, of a given size, made upon this principle.

Third,—The Egyptian lock; the essential principle of which was, that of moveable pins, or studs, dropping into and securing the bolt, all of which must be raised to the proper height by corresponding pins in the end of the key, before the bolt could he unfastened. This lock was the foundation upon which most of the ingenious inventions of late years had been based, differing only in the forms of the moveable obstructions to the bolt,—some of which acted vertically, others horizontally, some with a rotatory motion, and many others in an endless variety of ways; but of all these it was thought sufficient to describe only those best known and appreciated, namely, Barron's, Bramah's, and Chubb's.

In Barron's lock, patented in the year 1774, a great improvement was made upon the ancient Egyptian, by the introduction of the over-lift, wards being also used; but from the fact of there being only two tumblers, it was evident that no great change, or permutation, could be made in the combinations.

In Bramah's lock, patented in the year 1784, there was a compound of both direct and rotatory motion given to the key, instead of simply the latter, as in Barron's lock. It consisted of a number of sliders, having notches of various depths cut on one edge, so that the motion of the bolt was totally prevented until each slider was pressed down to its exact depth, which was effected by the key having six cuts in it of different lengths.

In Chubb's lock, first patented in 1818, and since modified and improved by various subsequent patents, there were six separate and distinct tumblers, placed over each other, and capable of being elevated to different heights, but all moving on the centre pin. This lock differed from the others in having a "detector," by which any attempt to pick or open the lock with a false key, was immediately notified on the next application of its own key.

Calculations were then gone into, to show the number of different combinations which might be made in this lock, and it appeared, that with an average sized key, having six steps, each capable of being reduced in height twenty times, the number of changes would be 86,400; that if the seventh step, which threw the bolt, was taken into account, the reduction of it only ten times would increase the number to 864,000. Further, that as the drill pins of the locks, and the pipes of the keys,

might be made of three different sizes, the total number of changes would he 2,592,000. In keys of the smallest size, the total number would he 648,000, whilst in those of the largest size it would be increased to 7,776,000 changes.

In conclusion, it was stated, that the manufacture of locks and keys was principally carried on at Wolverhampton and the adjacent towns, Birmingham, and London; and that the fundamental principle upon which all locks should be made, were,—perfect security; strength, so as to resist attempts to force them, or of opening by picklocks and false keys; simplicity in the arrangement, so that any stranger, having tbe proper key, might be able to open tbe lock; and durability.

Tbe paper was illustrated by a series of diagrams, and a variety of specimens of the locks and keys noticed in the paper; and also by a number of Gothic locks and keys of very elaborate workmanship, suitable for ecclesiastical buildings, &c., from Mr. Chubb's works, in London.

In tbe discussion which ensued, many additions were made to the historical part of the subject, and various ingenious contrivances were described, which had been successfully applied to give increased security to locks of ordinary construction. The combinations in the locks of Sommerford and M'Kinnon (of New York), were also fully described; an advantage being claimed for the former, in making one tumbler to lift and the other to fall, in order to open it; and for the latter, that, by the addition of a curtain of case-hardened iron, three-quarters of an inch in thickness, radiating from the centre of the pin, and a radiating key, there were no means of reaching the tumblers, for the purpose of taking an impression, or otherwise, except by cutting through that curtain. On the other hand, it was positively asserted, that no impression could be taken off, or means invented for picking, a lock which had six tumblers, although it could be easily done with locks having fixed wards; further, that Chubb's lock was a decided improvement on all others of the same character, inasmuch as it possessed a "detector," which formed really tbe peculiar feature of that lock; the excellence of the workmanship tended also to the facility of action, and consequent durability, for wbich it was so celebrated.

April 16.

Discussion upon Mr. Cbubb's paper, "On Locks and Keys." Several locks, which had not been previously mentioned, were exhibited, and tbeir peculiarities of construction were described. These bore the name of their inventors—Davis, Parsons, Williams, and Nettlefold.

It was urged, that the curtain which had been mentioned, might be essential for Summerford's lock, but could not be in any degree useful in Chubb's lock; in fact, tbat its only effect would he to induce complication, and augment the cost, without increasing the security.

Among numerous instances of ingenious devices for opening locks, that stated to have been tried in America excited much attention. The process was described to be, that the operator, after inserting two pieces of india-rubber to limit the sphere of action, injected from a force-pump a composition of glue and molasses, in a heated state, which chilled quickly, and, although extremely elastic, had the property of retaining the form and position of the lower side, or bellies of the tumblers, and tbat, after being cut out of the lock by a thin-bladed instrument, a key could be made from the impression.

In explanation of this, however, it was shown, that in Chubb's lock there existed no similarity between the position of the bellies of the tumblers when at rest, and the figure of the bit of the key; and therefore, that even supposing it to be possible to obtain an accurate impression of the position of tbe bellies of tbe tumblers when at rest, no indication would be afforded of the combination, or any assistance be given for making a false key. In further confirmation of this, a lock by Chubb was sbown, in which, when at rest, the bellies of the tumblers were perfectly uniform, and in the same plane, so that an impression of the inside of such a lock must be utterly useless for any purpose.

Although it had been asserted that Chubb's locks had been picked, it was admitted that it had never been proved that those locks had really been made by the inventor; but, on the other hand, it had frequently been shown that spurious imitations of the first expired patent had been sold in large quantities, and had been marked "Chubb's Patent," until the makers were stopped by legal process, when it was ruled, both at law and equity, that although, after the expiration of a patent, any person might manufacture the article, he had no right to pirate a peculiar trade mark, or to use a distinctive stamp, which was irrespective of any patent right.

Tbe locks nsed at Pentonville prison were instanced as uniting goodness and safety with extreme cheapness; but it was admitted that the workmanship was very inferior to that of Chubb's locks.

It was also asserted that Davis's locks, invariably used on the Cabinet Despatch-boxes, which frequently contained important secret papers, were never found to be out of order, or to be susceptible of being picked.

To this it was replied, that Mr. Chubb was prepared to produce a workman, who, without having ever previously seen the locks on the Cabinet Despatch-boxes, would open any number, on being allowed half an hour for each; and that the same might he done more easily with the Pentonville prison locks.

In summing up the discussion, it was stated to be the duty of the Institution to express the conviction, of a veritable Chubb's lock never having been picked either in Great Britain, or on the other side of the Atlantic; that it did, in fact, combine that strength, simplicity, and security, without which the most ingenious locks were utterly useless; that it possessed the merit, in the production, of never, through fear of competition, having reduced the quality of the workmanship to meet a reduced price; and that, by a due consideration of the workmen employed in the manufacture, the men had been taught to be as jealous of their master's reputation for good work, as he could be of himself, and that thus the merited reputation of the work had been, and was still, maintained.*

April 23.

"Description of the Insistent Pontoon Bridge, at the Dublin Terminus of the Midland Great Western Railway of Ireland," by Mr. R. Mallet.

This bridge was stated to be situated on the line of approach from the city to the terminus, and formed a passage over one branch of the Royal Canal, where it crossed the Phibsborough Road, upon the Foster Aqueduct. By the act it was provided, that the navigation of the canal should he as free and unimpeded as possible; and from the circumstance of there being only a height of 16 inches between the intended surface of the road, and that of the water of the canal, it necessarily involved the placing of some kind of moveable bridge, of rather a peculiar construction. After due consideration, the one described in the paper was designed and adopted, as being more suitable to the peculiarities of the situation than any other, owing to the water-channel being only 17 feet 4 inches in width, and that the passage to be made across it required to be at least 50 feet in breadtb.

The general idea of tbis form of moveable bridge, was that of a pontoon, or flat-bottomed boat, constructed of iron; the breadth being nearly equal to that of the water space to be crossed, and the length about equal to the width of roadway required. The deck beams of this pontoon projected over the sides, and rested, while *in situ*, upon a rabbate, or continuous recess, formed along the top course of each quay wall; but while tbe pontoon was floating light, the projecting deck beams were 2 inches clear of this rabbate, and the roadway platform, constituting the deck of the pontoon, was elevated to an equal height above tbe level of the top of the quay walls, or land, on each side; in this state the pontoon could be freely and readily pushed along the canal, for a distance of rather more than its own length, until it was brought opposite to lye-by, provided by increasing the width of the canal at this point, and being put therein the navigation was perfectly free.

As a pontoon afloat would form a very unstable roadway for carriages, means were provided for allowing it to settle down in the water, and rest firmly upon the rabbates; and also for again raising it rapidly, so as to float clear of the rabbates, and enable it to be moved away into the lye-by. For this purpose two large valves were placed in the bottom of the pontoon, one near each end, by which water was allowed to enter and sink the pontoon, until it hung upon the projecting deck beams. For removing this water, when it was required to float the pontoon, a large syphon, of a particular construction, was provided, which was capable of being brought instantly into use, and of being as quickly detached, when a sufficiency of water had been withdrawn to enable the pontoon to be moved. These operations were stated to be performed very readily by one man, the navigation being cleared in four minutes, and the roadway restored in less than three minutes.

Tbe details of the construction of tbe pontoon, of the syphon, and all other parts of the work, were then minutely given; also the total cost of the structure, which, exclusive of the masonry, was £1,125, that of the masonry being about £150; and it was stated to have continned in use, with perfect satisfaction, since its completion in February, 1847.

This form of construction was considered to be applicable in situations where a comparatively narrow water channel had to be crossed by a very wide roadway; but as the particular circumstances of other localities might differ from the one in question, the author suggested various alterations in the details, so as to meet these exigencies.

"Description of a Wrought-iron Lattice Bridge, constructed over the line of tbe Rugby and Leamington Railway," by Mr. W. T. Doyne.

This bridge, which was 150 feet span, carried a public road over the Honingham cutting. It consisted of two girders, 156 feet in length, and 10 feet 6 inches in depth, placed at a distance of 20 feet apart, and connected together by means of wrought-iron transverse girders, and by a system of horizontal diagonal bracing. The bottom of the main girders were formed of two angle-irons, and wrought-iron plates, eight in number at the centre, but diminishing to three at the ends, and of such dimensions as to make the effective sectional area at the centre, after deducting the loss by rivet holes, equal to 26 square inches; that of the top, which was somewhat differently constructed, so as the better to resist compression, being equal to 40 square inches. The lattices were formed of a series of bars of spoke-iron, intersecting each other at an angle of 60°, being crossed at those points by longitudinal bars, for the purpose of giving additional rigidity, and of making a closer parapet. The transverse girders, 7 feet 6 inches apart, were each formed of a plate of wrought-iron, with two angle-irons at the top and the bottom; these were covered with corrugated galvanized iron, one-tenth of an inch thick, upon which concrete, and then a layer of gravel and loam metalling, 6 inches thick, were laid. This bridge was erected by Messrs. Smith, Smith, and James, of Leamington, upon a platform which gave to the girders a camber of 7 inches in the centre, which was reduced to $3\frac{3}{4}$ inches upon removing the platform. The total cost of the bridge was about £3,500.

During the progress of the works, the author made some experiments upon the strength of rivets of different sizes, from which it appeared, that the average breaking weight, per square inch of sectional area, was 35·10 tons for a chain joint, and 18·82 tons for a lap joint.

April 30.

"On the Absorbent Power of Chalk, and its Water Contents, under different Geological conditions," by Professor D. T. Ansted.

* Not a word is here said in reference to Mr. Cotterill's most ingenious locks, described and illustrated by us at page 183, vol. ii. of this Journal. Certainly no examination into, or statement of the qualifications of modern locks, can be called complete, without a reference to them.—Ed. P. M. Journal.

After explaining the nature and extent of the chalk rock of England, both geologically and topographically, and briefly describing its chief physical peculiarities, the author proceeded to detail the results of some experiments made for the purpose of ascertaining the positive and relative absorbent powers of different kinds of chalk, when exposed to moisture under various circumstances.

The specimens experimented on were small cubes, each weighing from three to four ounces, taken from different districts, and geological positions, in the upper, middle, and lower beds of the chalk.

From these experiments it appeared, that the upper chalk, when it was to all appearance perfectly dry, contained about one-third part of a pint of water in each cube foot, which was never parted with under any conditions of dryness of the atmosphere; that in the case of an exposed surface of the rock, the absorption from a moist atmosphere would be unimportant, although, when water was presented to it in a liquid form, the upper chalk was found capable of receiving into its mass a quantity of water, amounting to more than two gallons for every cube foot of rock, beyond the quantity usually contained in apparently dry chalk, under ordinary exposure.

A specimen of the middle chalk, when thoroughly air-dried by six months' exposure, was found to contain about 23 parts of water in 1000 parts; three-fourths of which water were readily given off by subsequent exposure to a perfectly dry atmosphere, very little more than the original quantity being re-absorbed on exposure to a saturated atmosphere; showing that the absorbent power, in this respect, was even less than in the case of the upper chalk. The quantity of water contained in a cube foot of saturated middle chalk was rather more than two gallons.

A specimen of the lower chalk was found to contain more than 10 parts of water in 1000 parts, about three-fourths of which were rapidly parted with, on exposure to a perfectly dry atmosphere; but the rest, amounting to more than the quantity of water contained in the upper chalk, in its ordinary state, was not parted with by any exposure, short of a vacuum. On subsequent exposure to a saturated atmosphere, more than $15\frac{1}{2}$ parts of water in 1000 parts were absorbed, and when the specimen was saturated, its water contents exceeded $2\frac{1}{8}$ gallons per cubic foot.

It was stated that the upper chalk might generally be regarded as the *conducting*, and the lower chalk as the *containing*, part of the formation, so far as water was concerned; and that chalk must be regarded as a rock, which everywhere admitted the percolation of water, receiving into itself, and conveying to its lower beds, the water that fell on, or was brought to, its surface. This readily explained the uniformly dry appearance it presented, and the absence of any streams, arising from mere surface drainage, where extensive exposure of the rock itself occurred. It also appeared that particular bands of rock contained much more water than others, some, indeed, being apparently, though not really, dry, when below the surface of permanent wetness; while others gave off water readily, and to a large extent.

The probable effect of rain-fall upon the surface of the exposed chalk was then considered, and it was estimated, that at least 18 inches descended annually to what was called the surface of permanent wetness, maintaining a general and rude parallelism with the surface of the ground; but when the chalk rock was permanently covered with impermeable soils, as in the London basin, the position of the surface of permanent wetness was liable to extreme variation, and to be most seriously affected, as lateral percolation was then the only source of wetness.

On the other hand, it was thought that a large portion of chalk rock existed in a state of uniform and permanent wetness, and that wherever the gault extended, underlying the chalk and keeping up the water, there must be, at and below a certain depth from the surface, a supply of water to the extent of 180 millions of gallons for each square mile one yard in thickness; and that the surface of permanent wetness, dependent chiefly on the present rain-fall, was so far above this lower surface of saturation, as to insure a supply at least equal to one-half of the rain falling on the immediately surrounding district.

"On the application of Water Pressure as a Motive Power, for working Cranes and other kinds of Machinery," by Mr. W. G. Armstrong, Assoc. Inst. C.E.

This paper was a digest of the results of the author's extensive experience in hydraulic machinery, and referred in particular to the "Water-Pressure Engine for Mines," noticed by us last month.

INSTITUTION OF MECHANICAL ENGINEERS.

JANUARY 23.

"On Railway Carriage and Waggon Springs," by Mr. W. A. Adams of Birmingham.

The *Waggon Bearing Spring* in ordinary use on the Midland, London, and North-Western, and other railways, is 3 feet 3 inches long, $6\frac{1}{2}$ inches camber, $4\frac{13}{16}$ inches thick, and 3 inches wide, consisting of 15 plates, of which two are $\frac{3}{8}$ inch, and the rest $\frac{5}{16}$ inch thick, and the spring averages in weight about 93 lbs.

This spring is used to sustain loads not exceeding 6 tons on the four springs, exclusive of the waggon body; the waggon body weighs barely 2 tons, making the total load about 8 tons, or 2 tons per string.

By actual experiments this spring deflects with

1 ton	2 tons	3 tons,
$\frac{7}{8}$ inch	2 inches	$3\frac{1}{4}$ inches,

and will prove flat without setting or breaking.

It is to be noted, that in originally proving this spring flat it had set about $\frac{3}{8}$ inch, but that with the same extent of proof it will not again permanently set, having this property in common with other materials.

This spring would well sustain a load of 3 tons in actual work, as the concussions received upon the rails would probably not at any time increase the deflection $\frac{1}{2}$ inch; consequently, the load of 2 tons is being sustained on a spring far too rigid, to the detriment of the road and the waggon, and the original first cost is considerably more than it need have been.

Formerly, various plans were adopted to lessen the friction at the ends of the springs by the use of rollers, but these plans are now obsolete, the amount of friction not being found practically detrimental.

The points of the plates of laminated springs were formerly tapered in thickness, but now the usual plan is to form the taper in the breadth by cutting the plates at the ends in a triangular form. This method is found much more certain in its effect, is neater in appearance, and cheaper in manufacture. The cutting is generally performed either with the shearing machine, or between dies in a punching machine, the scraps being used in the melting-pot for cast-steel.

The *Waggon Bearing Spring*, or more correctly speaking, *prop*, in extensive use on the North Branch of the London and North-Western, the South Staffordshire, Caledonian, and other railways, and which may well be designated by the term *cheap*, is 2 feet 5 inches long, 4 inches wide, 2 inches thick, camber 4 inches, consisting of 4 plates $\frac{1}{2}$ inch thick, and weighs about 40 lbs. Actual experiment furnishes the following deflections:—

1 ton	2 tons	3 tons
$\frac{3}{8}$ inch	$\frac{3}{4}$ inch	$1\frac{1}{8}$ inch.

The cause of the immense sustaining power of this spring has been explained before in the observations on thick and thin plates.

The writer has already endeavoured to explain that the ordinary spring is too rigid; what therefore must be the wear and tear of rails, wheel tyres, vibration to the axles, and general wear and tear to the waggon and load caused by this rigid spring? Compared with the first-mentioned spring, this spring affords less relief in the proportion of 6 to 16, and is the furthest removed from the object required to be attained.

The *Waggon Bearing Spring* in extensive use on the Midland, Great Western, and other Irish railways, and on the London and North Western Railway, is the ordinary spring, but with eyes rolled at the ends and hung on scroll-irons.

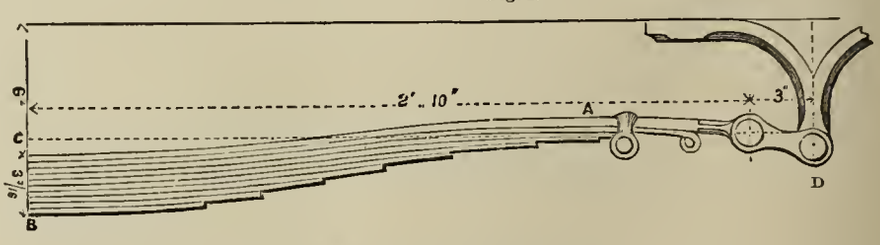
The advantages of this form of spring are the great space passed through, and quickness of adaptation to the inequalities of the road, in consequence of the deflection of the end shackles caused by the deflection of the spring, and consequent elongation between the centres of eyes of shackles; also the rubbing friction at the ends is almost entirely obviated.

The disadvantages are—First, that to carry a given load, a much greater quantity of material is required, as from the circumstance of a great portion of the space between the sole-bar and the axle-box being taken up by the scroll irons and shackles, the radius of the curve of the spring is much reduced, and a thicker spring consequently required.

Secondly, the tension on the sole-bars tending to hog the waggon frame, being the reverse of the action of the ordinary spring.

Thirdly, in consequence of the great space passed through by the deflection of this spring, the variations of the load will considerably vary the height of the buffers from the rails.

Fig. 1.



1-10th.

Fig. 1 represents the now universal *Carriage Bearing Spring*, originally introduced by Mr. Wharton on the London and North-Western Railway, as the result of repeated practical trials and improvements; theory would probably have never attained a similar result.

This spring is 5 feet 3 inches long, 3 inches wide, $2\frac{13}{16}$ inches thick, and consists of 9 plates $\frac{5}{16}$ inches thick; the ends of the plates are what is technically termed long spear-pointed.

Fig. 4 represents the spring when loaded, and the peculiar camber before fixing is made by setting the plates entirely at the centre, instead of the plates being set into a curve throughout their whole length, as in other springs. In fixing this spring, the tension-brace is adjusted between scroll-irons, with intervening compensating shackles. The tension-brace is 3 inches by $\frac{3}{8}$ inch, and thickened at the ends to $\frac{5}{8}$ inch. The spring is then compressed between the axle-box and the brace.

The action of the spring and brace is that of a lever-spring combined with a tension-brace, but the spring is so thoroughly overpowered by the leverage of the brace and the weight of the load, as to have little or no power of reaction or displacing the inertia of the load, beyond that of recovering its original position, thus affording the well-known smoothness and steadiness of action of this construction of carriage spring.

The brace is acted upon principally at the point, A, but nevertheless, when the blow from the rod strikes the point, B, and the spring and brace straighten at

that point, the curving and straightening of the brace at A, is compensated by the straightening and lengthening at C, the amount of tension at D being thus at all times about the same. The tension brace steadies and counteracts the power of the spring, and the spring partly relieves the brace by sustaining it at A.

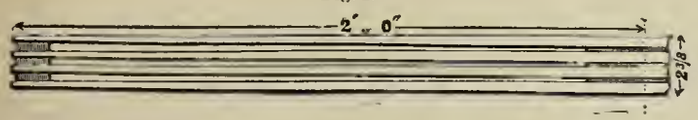
This combination also affords the means of firmly attaching the axle-box to the spring and brace, and thus holding it independent of the axle-guards, which in this case are wholly *guards* not *guides*, the guards neither touching the axle-box on the edge or side. Thus the effects of the inequalities of the road laterally and horizontally, are only transmitted through the elastic medium of the spring.

Springs of the same construction, but shorter and lighter, are now generally used for horse-boxes, carriage-trucks, and break-vans.

Buchanan's Bearing Spring consists of four flat horizontal plates 4 feet long, 4 inches wide, and tapered in thickness from $\frac{1}{2}$ inch at the centre, to $\frac{1}{4}$ inch at the ends, and fastened in the centre and impinging at the ends only, as in fig. 2.

It does not seem to possess any advantage over the ordinary laminated spring,

Fig. 2.



excepting that the friction between the plates is entirely avoided except at the ends; but at the same time it must be borne in mind, that in ordinary laminated springs the steel is rolled concave, therefore the plates bear at the edges only, which very considerably reduces the friction.

The disadvantages of this spring appear to be, firstly, that the extreme points of support are when the spring is weighted considerably below the centre bearing, necessitating the use of deep scroll-irons in carriages and bearing-blocks in waggons.

Secondly, the manufacture is costly and uncertain, from the fact of the plates being tapered in thickness, and the difficulty of hardening and tempering plates that taper in thickness.

Thirdly, when fixed with scroll-irons, the sustaining power is partly derived from its effect as a tension brace.

Adams's Bow Spring, of the size used for passenger vehicles, is 6 feet long from centre to centre of spring eyes, and the versed sine about 14 inches when weighted; the plates are 8 inches broad in centre, and tapered in width to 5 inches at the eyes, and the thickness is $\frac{9}{16}$ inch.

The advantages of this spring are—

Firstly, it holds the axle-boxes without the intervention of the guards, in the same manner as previously described with reference to the carriage-bearing spring.

Secondly, that the top links permit the wheels, axles, and axle-boxes to traverse laterally in passing curves and other impediments.

Thirdly, that the quick adaptation of this spring to lateral and perpendicular blows, preserves the inertia of the body almost wholly from displacement at moderate speeds.

The disadvantages are, that at high speeds and on a bad road the reaction of this spring is so great as to cause a rebound, and the gradually increasing momentum from each successive blow occasions very considerable oscillation.

This property has completely negatived its use for 4-wheeled carriages; but it is now used successfully under the 8-wheeled carriages on the North Woolwich branch, and there works to considerable advantage, permitting the wheels to adapt themselves freely to the curves of the road. The oscillation is there almost wholly obviated, from the fact that the blows are received upon eight points, and that the reactive power of a blow on one of the eight points is not sufficient to disturb the inertia of the load.

This spring has been and is now used to a very considerable extent on 6-wheeled carriages in Germany; but it is to be observed that the speed on the Continent is generally slower than in England.

Buffer and Draw Springs.—The ordinary laminated buffer and draw spring is 5 feet $4\frac{1}{2}$ inches long, $5\frac{7}{16}$ inches thick, and 3 inches broad, consisting of 17 plates, the outside plates $\frac{3}{8}$ inch thick, and the remainder $\frac{5}{16}$ inch; the camber when at rest being 13 inches.

These springs are generally fixed in the centre of the carriage, sliding between four bars of iron, ordinarily termed the "buffer-spring cradle." The ends are acted upon by the four buffer rods, and the draw-bar is cottered to the centre of the spring. The same methods have been tried to obviate friction at the ends as have been already mentioned with respect to bearing springs, but these plans are now obsolete.

In fixing the springs on carriages they are generally compressed one inch, and in waggons to the extent of about one-third of the stroke. The stroke of the buffer rod is limited to such an extent as will not deflect the spring beyond a straight line.

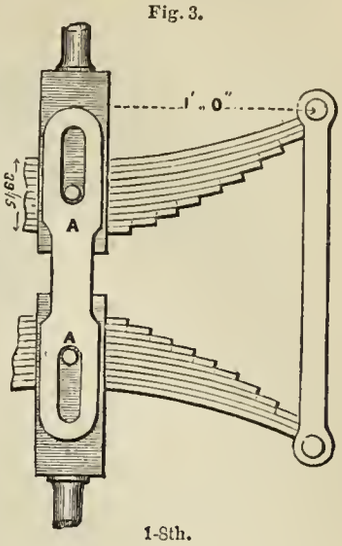
The sustaining power of this spring is equal to about 2 tons 14 cwt., or equal in all, including both ends of carriage, to about $2\frac{3}{4}$ tons, developed through a stroke of 2 feet.

As yet this method of buffing has not been surpassed or equalled, as none of the modern substitutes will give this moderate amount of resisting power developed through so great a space as 2 feet: also the weight of the buffer springs being in the centre of the carriage, and the springs acted upon by long buffer rods, cause the action to be very steady.

The *Double Draw Springs*, with a check-bar to limit the action within the straining point, make, probably, the only truly effective method yet adopted. It is to be observed, that the springs, when drawn home, are limited in their action by the check-bar, A A, thus forming a continuous rigid draw-bar. See fig. 3.

The springs are each 2 feet long, $3\frac{9}{16}$ inches thick, and 3 inches wide, consisting of 11 plates, of which 2 are $\frac{3}{8}$ inch thick, and the remainder $\frac{5}{16}$ inch; the camber is $3\frac{1}{2}$ inches before fixing; the springs are each compressed $\frac{1}{2}$ inch in fixing. The method of fixing is the same as already described for the laminated buffer spring.

Fig. 3.



1-8th.

External Buffers.—Within the last few years a considerable number of external buffers have been introduced, consisting of a cylinder and piston packed with nearly every available elastic substance, and practically varying only in the material of the packing.

De Bergue's Buffer Spring is packed with rings of vulcanised india-rubber. There are 4 rings, $5\frac{1}{2}$ inches diameter, and $1\frac{1}{4}$ inch thickness each.

In the opinion of the writer, this is the least effective of any yet produced, as the stroke is very short, and then only moderately developed under enormous pressure. It is questionable whether, in the event of a collision, the train would not collapse and leave the rails, before the immense sustaining power of these springs was fully developed.

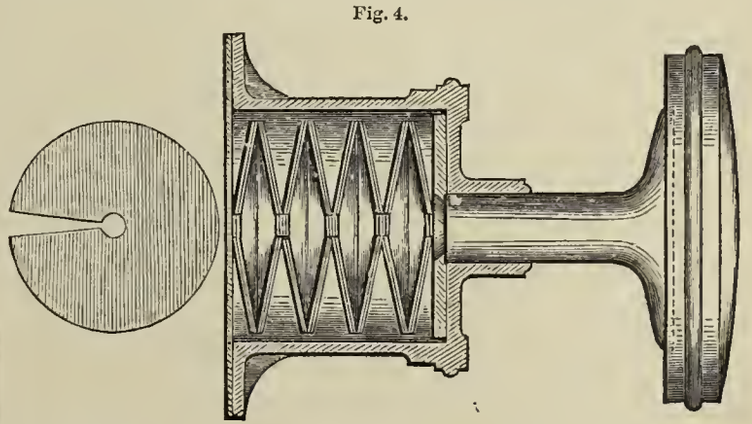
This buffer has an apparent stroke of about 3 inches; but it appears that to drive up the pair of buffers $1\frac{1}{2}$ inch would require a force of 3 tons.

By reference to the description of the ordinary laminated spring, it will be observed that the stroke is 12 inches with a force of $2\frac{3}{4}$ tons; being 8 times the length of stroke with a rather less force.

It is also questionable whether the vulcanised india-rubber is of that imperishable nature originally supposed. The writer has had in his possession a considerable quantity of vulcanised elastic bands for papers that have become completely rotten.

Adams's Disk Buffer has the packing consisting of 16 disk springs made from flat circular plates of steel 8 inches diameter and $\frac{1}{8}$ inch thick, with a radiating piece, A A, cut out to enable the plates to be pressed to a conical form, as in fig. 4.

Fig. 4.



This buffer spring is superior to the foregoing, inasmuch as the total amount of stroke is wholly developed, and the power can be properly adjusted by the thickness of the plates; the total length of stroke is $5\frac{1}{2}$ inches.

Webster's Air Buffer exhibits considerable ingenuity, but is more complicated than the other plans. The air piston is 6 inches diameter, and the leather packing is distended by a vulcanised india-rubber ring; the length of stroke is 4 inches.

In the event of leakage during the stroke, the piston would not return to its original position, and to effect this a small spiral spring is employed which drives back the piston. A small valve admits air at the time that the piston is recovering its position to compensate for leakage during the stroke.

Spiral Buffer and Draw Springs are used to some extent, but they are liable to the same objections already described with reference to the spiral bearing springs.

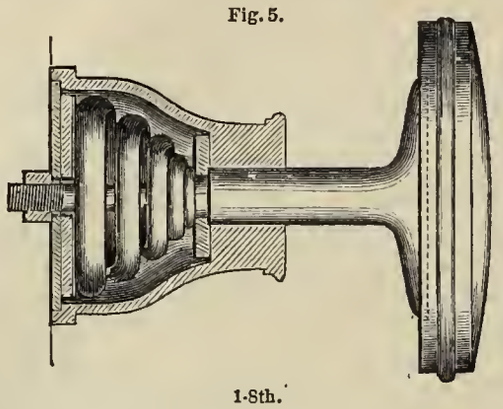
Brown's Conical Spiral Spring Buffer appears to be the least objectionable of these: it is shown in fig. 5. The resisting power is that of a spiral spring made in the form of a cone $7\frac{1}{2}$ inches diameter at the base, and the spring has the advantage of rotating at the point of the cone, thereby considerably easing the tendency to fracture or strain the particles of the steel; the steel is 1 inch wide, and $\frac{5}{8}$ inch thick at the base of the conical spiral, and is tapered for the last three coils to $\frac{1}{2}$ inch diameter at the point of the cone. When driven home, the spring forms a complete flat volute.

The sustaining power of the spring is about equal for the space passed through to that of the ordinary laminated buffer spring, but with a shorter stroke, the length of stroke being only $3\frac{1}{2}$ inches instead of 12 inches. From its compactness and comparatively moderate price, it is, in the writer's opinion—should the springs be found to stand their work—the most eligible of the external buffers, but

yet far from equalling the result obtained by the use of the laminated buffer spring and buffer rods.

The whole of the cylinder and piston buffers are liable to the defect of the piston being guided through only a short length, and consequently they cannot work with the smoothness of the long buffer rod guided in several places. This more particularly applies in the event of an oblique blow upon the buffer.

Fig. 5.



1-8th.

In conclusion, it is suggested that it would be desirable for a correct table to be formed of the sizes, weight, sustaining power, and deflection of laminated bearing and buffing springs, as a uniform guide in their practical application.

The writer purposes, should it be desired by the meeting, to prepare a laminated waggon-bearing spring, with axle-box and adjustments complete, on the principles pointed out at the commencement of this paper, viz., to obtain the present amount of efficient results with the smallest quantity of material.

MONTHLY NOTES.

Aitken's Steam-Engine Improvements.—We have received some sketches and general particulars of a bunch of modifications in the condensing apparatus of steam-engines, by Mr. John Aitken of Newman Street, London, promising to aid the working of this important department. In the first arrangement, the inventor adds what he terms a "vacuum tube" between the upper ends of the air-pump and condenser, respectively; this tube having a plain clack-valve in it, opening towards the pump, or, in other terms, he connects the upper ends of the air-pump and condenser by a passage like that of the foot-valve. In the ordinary single-acting air-pump, when the bucket descends, it leaves a partial vacuum above it; and being inert during this descending movement, the vapour has a tendency to collect in the condenser. By Mr. Aitken's modification, the pump is, to a certain extent, made double-acting, as, when the bucket descends, the vapour in the condenser, lifting the valve in the connecting passage at the top, passes into the upper part of the air-pump. This plan is stated to increase the vacuum from $\frac{1}{2}$ to $1\frac{1}{2}$ inches, whilst the vapour passed into the air-pump renders the action of the water on the delivery-valve more easy. A second plan involves the application of an "atmospheric cylinder," immediately over the air-pump cover; this cylinder being fitted with a piston, fast on the pump-rod, which passes up directly from the air-pump, through the cylinder above. The condensing water is brought by a horizontal pipe through an equilibrium valve into the bottom of this cylinder, and a similar valved-passage discharges it from the cylinder to the condenser. On the first movement of the engine, the admission-valve for the water is opened by the eccentric, when the pressure of the atmosphere upon the water forces the piston up into the vacuum. As soon as the piston reaches the top of its stroke, the admission-valve is closed, and the opposite one opened; the water in the cylinder then falls down into the condenser, and the piston is brought down without any resistance, leaving a vacuum behind it. The sketches before us show the arrangements as adapted both for marine and stationary engines. We give the inventor's notes of the advantages professed to be seeured by the adoption of his plans:—1. The air-pump is worked without any loss of power, excepting that which arises from friction, as every gallon of water admitted to the condenser exerts a power from atmospheric pressure equal to that required for its discharge. 2. For the same reason the vacuum may be much improved by the admission of a greater quantity of injection water, without the corresponding loss of effect which is found in the ordinary system. 3. The movement of the engine is rendered more steady, by the combined use of the atmospheric cylinder and the vacuum tube, as the resistance of the air-pump is counteracted. 4. There is great additional ease and safety in the working of marine engines, as the atmospheric cylinder measures the supply of the condensing water, irrespective of time, and in exact proportion to the speed of the engine; whereas at present the engine is apt to be overloaded with condensing water, while the engine and paddles are retarded by a heavy sea, whereby unsafe and uneasy working is produced. 5. It will obviate a difficulty frequently experienced in river boats, when the condenser is too hot to supply itself with water. The resistance from the air-pump thus removed may be estimated at from $\frac{1}{2}$ to $\frac{3}{4}$ lb., and the improved vacuum from additional water at $\frac{1}{2}$ to $\frac{3}{4}$ lb., or 1 to $1\frac{1}{2}$ lb. per square inch of the piston.

Brodie's Tile Machine.—A very important improvement in tile machines has recently been registered by Mr. W. Brodie of Airdrie, who has succeeded in producing a very convenient and efficient arrangement of mechanism. The machines which we have seen are portable, and are fitted to make tiles and clean clay at the same time. The production, per machine, is equal to 16,000 2-inch pipe tiles per day. We shall probably be able to give a drawing of the machine on an early opportunity.

The Exhibition of Industrial Art.—Every one who has given the smallest consideration to the objects of the forthcoming Exhibition of Industrial Art in 1851, must have been, by this time, fully impressed with a sense of the vast importance of the undertaking, to a nation which is so intensely industrious as ours. Whilst other countries have for years back profited by displays of the combined outpourings of industry, this, the greatest industrial arena which the world ever saw, has been contented with the isolated gatherings of its agricultural societies, and the minor provincial exhibitions of general productions put forth at distant intervals. Great Britain has yet to feel the sway which aggregations of products fail not to hold over industrial progress. France has already reaped the benefit at which we point: and here we may draw a moral. Until the last year, all the French expositions have been confined to arts and manufactures, excluding agricultural products; whilst in England, the exhibitions of our agricultural societies, isolated though they were, have had their effect in the improvement of the mechanism of the tiller of the soil; and, by contrast with certain manufactures, have shown what the latter have lost in the non-existence of any similar gathering for their exposition and comparison. The miserable state of French agriculture, and the excellence of the higher grades of French industrial art, are eloquent evidences of the results on each side of the argument. To France, where eleven successful exhibitions have been achieved, we, as it were instinctively, look for something to guide our opinions on the policy of the movement. In the first of these—1798—Brequet, the watch and clock maker; Lenoir, the mathematical instrument maker; and Didot and Herhan, the improvers of printing—men who have since secured for themselves the highest niches of fame—were all brought out, and gained prizes. In the second, Jacquard made his appearance, and carried off a high prize for the invention that has made his name immortal; whilst on the central jury for the time, we find the names of Berthollet, Berthoud, De Morveau, and De Prony. The third produced Montgolfier's hydraulic ram, and Aubert's stocking-frame: and in the fifth came Koechlin, the world-celebrated calico-printer; Raymond of Lyons, the inventor of the process of fixing Prussian blue in silk dyeing; and De Jouy, the discoverer of the well-known green; whilst Jacquard reappeared, and took a still higher stand. These are a few of the events of the earlier collections; and the later ones have gone on gradually developing all that was good in art—stimulating feeble minds, and rousing dormant ones—until, as was lately remarked by an acute observer—himself an eminent industrialist—that in many cases over which he had watched—the contributor gaining a bronze medal one year, secured a silver one in the succeeding attempt, and in the third, triumphantly asserted his right to one in gold. Some of our neighbours have asked, "What shall I gain by the exhibition?" another says, "As it is certain we shall in many instances fail in proving our superiority—why, by an exhibition such as this, admit our secondary rank, and confess ourselves beaten?" None of these can be said to have thought much on the subject. In the first, if we are to gain nothing by seeing, in one grand collection, the highest efforts of the world's art—the latest of the novelties of the entire globe—we admit that the inquiry is unanswerable. In the second, we have a most unfortunate observation—why, the very purpose of the affair is to investigate and decide who is pre-eminent in his particular art; and if we do really falsify our position by a mere pretence to excellence which is not, the sooner we candidly reform, the better. The consumers of industrial productions soon find out where they are best served, and any of our failures can no more than hasten a result which is inevitable at no very distant date. If we lose this time, we shall have before us the means of exactly ascertaining what we have still to accomplish, and this brings us to that most powerful of improvers—competition. Ask any manufacturer what his trade would have been but for competition—what cheapens all the products of our factories—stimulates genius to devise more effective mechanical agents—and makes two blades of grass grow where but one grew before—but competition. Others who have been at a dead loss for an argument to defend their apathy in the undertaking, hint something about "a free-trade movement;" and if by this they mean to tell us that it is sought to gain free trade in industrial art, they are right—for the aristocracy of industrial producers, wherever found, has a right to an aristocratical reward. He who has experienced the difficulty of satisfying himself upon the exact condition of any single branch of manufacture in even a limited district, will hardly require to be told of the advantage of an aggregation of products, not of one, but of every art, which the proposed exhibition will afford. Under one roof he finds selections of the best things from all quarters, which he could not see in the ordinary course of search without traversing the globe—and then comparison would be impossible. It is a deep mistake to suppose that we intend to pit ourselves directly against the whole world. We are merely fellow-candidates with other nations, who are to meet in friendly competition with each other on our shores. The most distant localities are preparing for the meeting, and some of the governments have contributed large sums to defray the costs to which their contributors will be liable. Various hints have been thrown out on the subject of the protection of new and vulnerable discoveries from piracy. Many ingenious men, who possess unpatented schemes, will be chary of bringing forward their plans, unless some guarantee is provided to secure to them their interest in what the law expressly states is not property, until legally covenanted for. If some proposal of the kind can be accomplished—well and good; but we see many difficulties in the way. Great Britain is committed to the due carrying out of the exhibition; let us hope that, as all her sons now know what is expected from them, they will not be found wanting on the day of competition.

Death of M. Gay-Lussac.—In the French papers we find recorded the death of M. Gay-Lussac, at the age of 71. His labours are chronicled in the history of nearly every physical and chemical science, and his discoveries are so numerous that we cannot assign to him any single performance.

Heath's Improvement in the Manufacture of Steel.—Mr. J. M. Heath, whose efforts in the Indian-iron manufacture we noticed some time back, proposes to make steel from iron, produced from ores, without being brought to the state of pig or cast-iron, by a new process of his invention. His object is to do

away with the impurities inseparable from the mode at present pursued, where the ore is first reduced to pig-iron. He first reduces the ore to a granular state, to facilitate the separation of earthy matters, and the pure ore is then to be reduced to the metallic state, by the deprivation of its oxygen through the agency of carbon, at a heat below the fluid point. To produce what he terms a perfect steel-iron, the inventor mixes with the cemented or deoxidised product, a small portion of oxide, or chloride of manganese, and a portion of coal or fir tar,—from one to three pounds of manganese, and from one to two gallons of tar, to a hundred pounds of the deoxidated ore. This mixture is heated in a furnace, and at the welding heat is formed into blooms in the usual way; the product being afterwards re-heated, and shingled for conversion into steel in the ordinary way.

Binocular Camera for the Production of Dissimilar Pictures.—The last Report of the Transactions of the Royal Scottish Society of Arts, contains a lithographed drawing of a pair of dissimilar pictures, produced from the same piece of statuary, by Sir D. Brewster's peculiarly elegant application of the binocular camera, showing the advantages which this contrivance gives to the artist in his delineations either of living bodies, buildings, scenery, or mechanism. The peculiarity of the process will be understood by considering the vision with one eye, of objects of three dimensions, as compared with that of both eyes. At a short distance, a colossal statue, for example, seen with one eye, gives a picture of all its visible parts upon the retina. Go further off, and certain parts cease to be seen, whilst others come into view. If the object is now looked at through a telescope, so as to present it with the same distinctness and apparent magnitude as at first, the two pictures will be very different; all the parts which ceased to be visible as we retired, will still be invisible; and all those not seen at the first position, but became visible on retiring, are now again seen in the telescopic picture. Thus, the parts seen by the near eye, and not by the distant telescope, will be towards the centre of the object; the surfaces of which converge as it were towards the eye; whilst those seen by the telescope and not by the eye will be the external portions, whose surfaces converge less, or approach to parallelism. On the nature of the building will depend which of these two pictures gives the most favourable representation.

If now the object is correctly reduced to half its size, then these two similar solids will afford a different picture, whether seen by the eye alone, or by the telescope. In the reduced copy, the inner surfaces visible in the original will disappear, whilst the outer ones become visible.

A repetition of these experiments with *two eyes* instead of *one*, will give a different representation. Surfaces and parts, formerly invisible, will become visible, and the body will be better seen because we see more of it: but the parts thus brought into view, being seen, generally speaking, with one eye, will have only one-half the illumination of the rest of the picture. Though we see more of the object in binocular vision, it is only parts of vertical surfaces perpendicular to the line joining the eyes, that are thus brought into view; the parts of similar horizontal surfaces being invisible, as with one eye. To see the horizontal as well as the vertical surfaces, we should require to have a pair of eyes placed vertically; and to obtain a perfect symmetrical view of the object, we should require a pair of eyes inclined at all possible angles—that is, a ring of eyes 2½ inches diameter.

These considerations bring us to the determination of the best method of producing dissimilar plane drawings of full-length and colossal statues, in order to reproduce them in three dimensions by the stereoscope. The necessary accuracy for this process is only attainable by the use of the Daguerreotype or Talbotype principle. For this purpose, a binocular camera is constructed, with two lenses placed at the same distance asunder as the two eyes; and this camera will give us, at the same instant, with the same lights and shadows, and of the same size, such dissimilar pictures as will reproduce them in relief in the stereoscope. We may conclude this rapid glance at this beautiful process, with the remarks of the inventor, Sir D. Brewster:—

"The art which we have now described cannot fail to be regarded as of inestimable value to the sculptor, the painter, and the mechanist, whatever be the nature of his production in three dimensions. Lay figures will no longer mock the eye of the painter. He may delineate at leisure on his canvas the forms of life and beauty, stereotyped by the solar ray, and reconverted into the substantial objects from which they were obtained, brilliant with the same lights, and chastened with the same shadows as the originals. The sculptor will work with similar advantages. Superficial forms will stand before him in three dimensions, and while he summons into view the living realities from which they were taken, he may avail himself of the labours of all his predecessors, of Pericles as well as of Canova; and he may virtually carry in his portfolio the mighty lions and bulls of Nineveh, the gigantic sphinxes of Egypt, the Apollos and Venuses of Grecian art, and all the statuary and sculpture which adorn the galleries and museums of civilised nations."

Ruthven's Steam-Ship Propelling Apparatus.—We have before us some printed remarks, containing a "Description of, and Observations on, the Patent Improvements in Propelling and Navigating Steam Vessels," by J. & W. M. Ruthven, Engineers, Edinburgh,—and from them we gather that the Messrs. Ruthven are about reviving their old proposal for the propulsion of ships by the reactive force of water-jets. Under the engine is a round iron case, having communication on the under side, at the centre, with a large flat pipe, going from thence towards the bow of the vessel, near which it has a free communication with the water, by means of apertures through the bottom of the vessel. The water thus enters the round iron case, in which there is a wheel, having a shaft through a stuffing-box on the upper side of the round iron case. On this shaft cranks are formed, and to these the piston of the engine is attached. The power of the steam-engine is solely applied to turning the wheel in the iron case. The wheel is made something like a fan-wheel, so that on revolving it carries round the water with it. The water, being revolved, presses towards the outer rim of the case with a force proportionate to the speed, and according to centrifugal force. At each side of the rim of the iron case there is an aperture and pipe, conveying the water from the case to each side of the vessel, where a nozzle, or bent pipe, discharges it outside of the vessel. This nozzle, or bent pipe, which is above the water line, is so arranged that it can be turned by the seamen on deck, so as to discharge the water either towards the bow or stern. When made to discharge the water towards the stern, the vessel goes a-head,—when towards the bow, the vessel goes a-stern,—when pointed downwards, the vessel remains stationary. During these operations, the engine does not require either to be altered or stopped. It may be mentioned that one nozzle may be altered without the other, so that having one pointed towards the stern, and the other towards the bow, the vessel goes round.

Before a steam vessel with paddle-wheels can be made to go a-stern, the engine requires to be stopped, and its motion reversed. The combined attention of seamen and engineers is thus rendered a source of much annoyance and difficulty in steam navigation; also, the turning of a steam vessel with paddle-wheels cannot be effected except by the helm, and this can only be done when in motion. To this may be added the great liability to collision, from the projection of the paddle-boxes, and consequent destruction to the paddle-wheels. Not only is the great breadth of paddle-wheels and boxes got rid of, but the vessel can be turned round while in a state of rest—that is, neither going a-head nor a-stern; and neither in this operation, nor in changing from going a-head to backing, is there any communication requisite with the engineers.

It will be observed, that a steam vessel with paddle-wheels can rarely take advantage of the wind, and then to a limited extent only, on account of the necessity of keeping her always in as upright a position as possible; it is thus evidently incompatible with sails to any useful amount. With the improvements proposed, there is no more limitation to the use of sails than in a sailing vessel, probably much less, and thus giving out the full and undiminished action of both propelling powers, the steam power being combined with the action of the sails. It may also be stated, that the vessel will sail without steaming, as well as a sailing vessel, in consequence of having no obstructions on the hull.

The projectors give twelve heads of improvement, in which their plan is professedly superior to the paddle-wheel system—the latter being taken as the most effective one now in use. These twelve reasons embody all the well-known points of efficiency sought by the advocates of the numerous propellers proposed to supersede the paddle, with one or two additional ones relating to the facilities for turning and steering the ship, afforded by the new plan. Such of our readers as are acquainted with Mr. Bodmer's propeller, will see at once, from the outline we have given, that Messrs. Ruthven are working on a precisely similar principle—at least as far as we can make out, without a drawing to guide us. Mr. Bodmer uses a *pair* of horizontal fan-wheels, placed one on each side the keel of the ship, and near the stern. These fans revolve at a high speed, and take in the water through the ship's bottom, by means of apertures formed on the lower sides of their cases. The water so taken in, is driven out in a joint stream at the stern of the ship. The only apparent difference between the two schemes is, that Mr. Bodmer made no provision for directing his reactive water discharge at any angle, as he intended to steer solely by the rudder, as at present. He had, however, we believe, an arrangement for varying the water discharge within certain limits, but not to the extent mentioned by Messrs. Ruthven.

The reactive system of propelling has had many admirers, but it has so far made little return for the scheming expended upon it. The plan of directing the jets at various angles was proposed many years ago, but we are not aware that it was ever tried until the present arrangement came into existence.

Lithographic Improvement.—In our recent notices of the proceedings of the Royal Scottish Society of Arts—page 287, vol. ii.—will be found a general report on a new invention in lithography, by Messrs. Schenck and Ghemar of Edinburgh. We have since seen a specimen of a drawing made according to this process, of which we now present some further particulars:—A grained lithographic stone is slightly warmed, and the composition used for rubbing in tint-stones, mixed with an addition of white wax, and a little copal varnish, is rubbed down upon it with a piece of coarse short-haired flannel or coarse cloth, until a uniform brown-grey tint is produced. The drawing is then either sketched on the stone with soft lithographic chalk, or traced in the ordinary way with red paper. The lighter parts may be rubbed lighter in colour—the highest lights being taken out with a scraper, which is also employed to blend the finer tints together. Darker parts may be rubbed in darker, and finished with softer or harder chalks, whilst the darkest tints are laid in with liquid ink with the brush or pen, and the stone is finally prepared with acid. We have a drawing now before us—by Mr. Ghemar—which speaks favourably for the new method. Its size is 7 inches by 4½; and it represents a fireman, with hatchet in hand, climbing a burning building amid a shower of sparks and fragments of timber. The tone of the drawing is somewhat similar to that of a delicately-executed charcoal sketch, bringing out the boldness and freedom of the artist's pencil, whilst it exhibits great firmness and brilliancy.

The great merit of the invention consists in its taking advantage of the chemical composition of the lithographic stone, and the chemical nature of its printing. Upon this basis the inventors have made experimental drawings; in which they have succeeded in producing, almost instantly, the middle tints of any surface, *which do print*—a result which in every other mode requires a considerable time.

Lead Statuary.—The hint for the adoption of lead for statuary purposes, noticed by us last month, has induced Mr. Nasmyth to speak a word in favour of the proposition. Owing to the comparatively low temperature at which this metal melts, and the ease and perfection with which it can be cast into the most intricate forms, he states, that our artists may now resume that admirable system of casting groups of statuary and other complex designs, in use during the finest periods of Italian and Greek art,—namely, the employment of wax as the material for the original work. Wax affords the greatest facility for execution, and when coated with plaster of Paris, it may be melted out, leaving a perfect mould. By this mode

the artist may revel in the most difficult "under-cutting," with a certainty that the details will be brought out with all the sharpness of the original. The addition of five per cent. of antimony, not only gives hardness to the metal, but increases the sharpness of the casts.

ENGLISH PATENTS.

Sealed from 18th April, to 17th May, 1850.

In our list of last month, page 48, "Robert Reid, Glasgow," for "certain improvements in propelling," read "certain improvements in *weaving*."

Peter Arkell, Chapel-street, Stockwell, Surrey, engineer,—"Improvements in the manufacture of candle wicks."—April 20th.

Alfred George Anderson, Great Suffolk-street, Southwark, Surrey, soap manufacturer,—"Improvements in the treatment of a substance produced in soap-making, and its application to useful purposes."—20th.

John Timothy Chapman, Wapping, Middlesex, engineer,—"Improvements in apparatus for setting up ships' rigging and raising weights."—20th.

Richard Archibald Brooman, of the firm of J. C. Robertson & Co., Fleet-street, London, patent agents,—"Improvements in the manufacture of zinc, and in the apparatus employed therein."—20th.

Henry Ritchie, Brixton, Surrey,—"Improvements in the manufacture of copper, brass, and other tubes or pipes."—23d.

William Macalpine, Spring Vale, Hammersmith, general dresser, and Thomas Macalpine, same place, manager,—"Improvements in machinery for washing cotton, linen, and other fabrics."—23d.

Charles Humfrey, Downing College, Cambridge, M.A.,—"Improvements in the manufacture of candles and oils, and in treating fatty and oily matters, and in the application of certain products of fatty and oily matters."—23d.

Antoine Pauwels, Paris, France, merchant, and Vincent Dubochet, also of Paris, France, merchant,—"Certain improvements in the production of coke, and of gas for illumination, and also in regulating the circulation of such gas."—23d.

Richard Laming, New Chemical Works, Isle of Dogs, Middlesex, chemist, and Frederick John Evans, Horseferry-road, Westminster, gas engineer,—"Improvements in the manufacture of gas for illumination, and other purposes to which coal gas is applicable, in preparing materials to be employed in such manufacture, and in apparatus for manufacturing and using gas; also, improvements in treating certain products resulting from the distillation of coal, parts of which above-mentioned improvements are applicable to other similar purposes."—23d.

Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in casting type."—(Being a communication.)—23d.

Pierre Armand Lecomte de Fontainemoreau, South-street, Finsbury,—"Certain improvements in the manufacture of wafers, and in the machinery or apparatus connected therewith."—(Being a communication.)—23d.

Pierre Armand Lecomte de Fontainemoreau, South-street, Finsbury,—"A new and improved mode of conducting, consuming, and disengaging smoke from its deleterious compounds."—(Being a communication.)—23d.

Ernst Werner Siemens, Berlin, Prussia, electric engineer,—"Improvements in electric telegraphs."—23d.

Joseph Jean Baranowski, London, gentleman,—"Improvements in machinery for counting, numbering, and labelling."—23d.

William Gilbert Elliott, Blisworth, Northampton, gentleman,—"Improvements in the manufacture of bricks, tiles, and pipes, and other articles from plastic materials."—(Being a communication.)—27th.

Charles May, Ipswich, engineer, and Robert Leggett, of the same place, foreman of mechanics to Messrs. Ransom and May, of the same place,—"Improvements in machinery for threshing and grinding corn, for cutting straw, and other similar substances; also, improvements in applying steam-power to give motion to such classes of machinery; and also, improvements in machines for depositing seed."—30th.

George Michiels, London, gentleman,—"Improvements in treating coal and in the manufacture of gas, and also in apparatus for burning gas."—(Being a communication.)—30th.

Evan Protheroe, Austin-friars, London, merchant,—"Improvements in the manufacture of oxide of zinc, and in making paints from oxide of zinc."—(Being a communication.)—30th.

Robert Dalglish, Glasgow, merchant and calico-printer,—"Certain improvements in printing, and in the application of colours to silk, cotton, linen, woollen, and other textile fabrics."—May 7th.

Gustave Eugene Michel Gerard, Paris, France,—"Improvements in dissolving caoutchouc (indian-rubber) and gutta percha."—7th.

George Hurwood, Ipswich, Suffolk, engineer,—"Improvements in grinding corn and other substances."—7th.

Joseph Gibbs, Devonshire-street, Portland-place, Middlesex, civil engineer,—"Improvements in artificial stone, mortar, and cements, and in the modes of manufacturing the same."—7th.

John Tatham and David Cheetham, Rochdale, Lancaster, machine-makers,—"Certain improvements in machinery or apparatus, and operations connected with the manufacture of cotton, wool, silk, and other fibrous substances and fabrics, and in the application of certain materials to the manufacture of textile fabrics."—7th.

George Robbins, Forest Lodge, Southampton, gentleman,—"Improvements in the construction of railway carriages."—7th.

John Youil, Ardwick, Manchester, brewer,—"Certain improvements in machinery or apparatus for washing, cleansing, filling, and corking bottles and other vessels."—8th.

SCOTCH PATENTS.

Sealed from 22d April, to 22d May, 1850.

T. S. Prideaux, Southampton, gentleman,—"Improvements in puddling and other furnaces, and in steam-boilers."—April 26th.

Charles Cowper, Southampton Buildings, Chancery-lane, Middlesex, patent agent,—"Certain improvements in the treatment of coal, and in separating coal and other substances from foreign matters, and in the manufacture of artificial fuel and coke, and in the distillation and treatment of tar and other products from coal, together with improvements in the machinery and apparatus employed in the said purposes."—(Communication.)—26th.

Lucien Vidie, late of Paris, France, but now of South-street, Finsbury-square, advocate,—"Improvements in conveyances on land and water."—27th.

Robert Dalgleish, Glasgow, Lanark, Scotland, merchant and calico-printer,—"Certain improvements in printing, and in the application of colours to silk, cotton, linen, woollen, and other textile fabrics."—27th.

Ethan Campbell, New York, United States of America, philosophical, practical, and experimental engineer, and a citizen of the said United States,—"Certain new and useful improvements for generating and applying motive power, and for propelling vessels."—30th.

Robert Reid, Glasgow, Lanark, manufacturer,—"Certain improvements in weaving."—May 3d.

Maxwell Miller, Glasgow, Lanark, coppersmith,—"Certain improvements in distilling and rectifying."—3d.

Thomas Keely, Nottingham, manufacturer, and William Wilkinson, of the same place, frame-work knitter,—"Certain improvements in looped or elastic fabrics, and in articles made therefrom; also, certain machinery for producing the said improvements, which is applicable, in whole or in part, to the manufacture of looped fabrics generally."—8th.

Pierre Armand Le Comte de Fontainemoreau, 4 South-street, Finsbury-square, Middlesex, Patent agent,—"Certain improvements in the production of heat and light, which improvements are applicable to ventilation and the prevention of explosions."—(Communication.)—9th.

Ethan Baldwin, Philadelphia, Pennsylvania, America,—"A new and useful method of generating and applying steam, in propelling vessels, locomotives, and stationary machinery."—9th.

Jacop Connop, Hyde-park, Middlesex, gentleman,—"Improvements in melting, moulding, and casting sand, earth, and other argillaceous substances, for paving, building, and various other useful purposes."—20th.

IRISH PATENTS.

Sealed from 21st April, to 19th May, 1850.

Willlam Garnett Taylor, Burton Hall, Westmoreland, gentleman,—"Improvements in lint and in linting machines, which improvements in linting machines are, in whole or in part, applicable to other purposes."—April 30.

William Brown, Airdrie, Lanarkshire, electrician, and William Williams, the younger, St. Dennis, Cornwall, gentleman,—"Improvements in electric and magnetic apparatus for indicating and communicating intelligence."—May 2.

George Edmond Donisthorpe, and John Whitehead, Leeds, manufacturers,—"Improvements in preparing, combing, and hackling fibrous matters."—10th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 18th April, to 17th May, 1850.

In our *Registration List* of last month, No. 2,248, for "Frederick Wilson, Leeds Rig Foundry"—read "Frederick Wilson, Railway Foundry, Leeds."

April 18th,	2269.	Richard Edwards, Bow,—"Knife-cleaning apparatus."
19th,	2270.	A. Marshall and Co., Parkside, Hyde Park-corner,—"Part of the apparatus used in corsets, denominated the 'Corset a tous Resorts.'"
20th,	2271.	J. Robertson, Emmett-street, Poplar,—"Apparatus for giving signals by sound."
—	2272.	Mary Ann Nash, Paul's-cray Mill, Kent,—"Impressing surface of a dandy roller, for producing water-marks on machine-made paper."
—	2273.	John Weems, Johnstone, Renfrewshire, and Thomas Buchanan, Bridge of Weir, Renfrewshire,—"Cover for carding and drawing-frame cans, applicable to cotton, flax, and woollen factories."
—	2274.	Alfred Gregory, St. George's-street East, London,—"Safety plate for a ship's scuttle."
—	2275.	Henry Potts, Brooke-street, Holborn,—"Postage-stamp damper and affixer."
22d,	2276.	Reeves, Greaves, and Reeves, Birmingham,—"Sword tang."
—	2277.	William Horne, Long-acre,—Barouche, or barouche-phaeton."
23d,	2278.	Robert Waddell, Liverpool,—"Capstan."
—	2279.	Crosse and Blackwell, Soho-square,—"Stopper for glass and earthenware bottles and jars."
—	2280.	Thomas Kerslake, Exeter,—"Boiler and furnace."
24th,	2281.	William Alex. Adams, Midland Works, Smethwick, Staffordshire,—"Carriage spring and centre clip."
—	2282.	Nicholas Downing, Phœnix Foundry, Shildon,—"Cast-iron railway carriage-wheel."
25th,	2283.	John Finlay, Glasgow.—"Radiating register stove."
26th,	2284.	James Cutbbert and Co., Great Distaff-lane, London,—"Apparatus for mulling liquids."
27th,	2285.	Charles Starkey, Bloxwich,—"Lock."
29th,	2286.	Hardman, Norton, and Co., Gresham-street, London,—"Attacher for coats and other garments."
—	2287.	Roland Fothergill, Aberdare Iron-works, Glamorgan,—"Sleeper for tram plates."
—	2288.	Joseph Peace, Sheffield,—"Saw handle."
30th,	2289.	Joseph Chatwin, Birmingham,—"Albert gas-burner."
—	2290.	Hall and Wilson, Manchester,—"Gas retort."
—	2291.	Edward Thomas Loseby, Gerard-street, Islington,—"Portable crane shower-bath."
—	2292.	Shoolbred and Loveridge, Wolverhampton,—"Hip bath."
—	2293.	Robert Barsby and William Wells, Dudley,—"Day indicator."
—	2294.	Samuel Daniel, Birmingham,—"Looking-glass movement."
May 2d,	2295.	Francis Pike Hewitt, Nottingham,—"Compound elastic band, or strap, for articles of dress."
4th,	2296.	Francis Drury, Albany-street, Regent's-park,—"Steel bell."
6th,	2297.	John C. Else, Albany-road, Camberwell,—"Beer and spirit preserver."
—	2298.	John Holford and Edward Barry Collard, Lord-street, Liverpool,—"Frame for carpet and other bags."
9th,	2299.	Dent, Allcroft, and Co., Wood-street, Cheapside,—"The Osborne cravat."
—	2300.	Thomas Lant, Birmingham,—"Fastening for trouser-straps."
10th,	2301.	John Masters, Leicester,—"Calesthenic or exercising belt."
—	2302.	Pemberton and Son, Birmingham,—"Casement fastener."

TO READERS AND CORRESPONDENTS.

J. W., London.—We are obliged by his favour.

T. P., Hants.—His scheme is impracticable for many reasons, besides the very simple ones already given. His other plans are under examination.

J. S. N.—His drawings are being engraved for our July part.

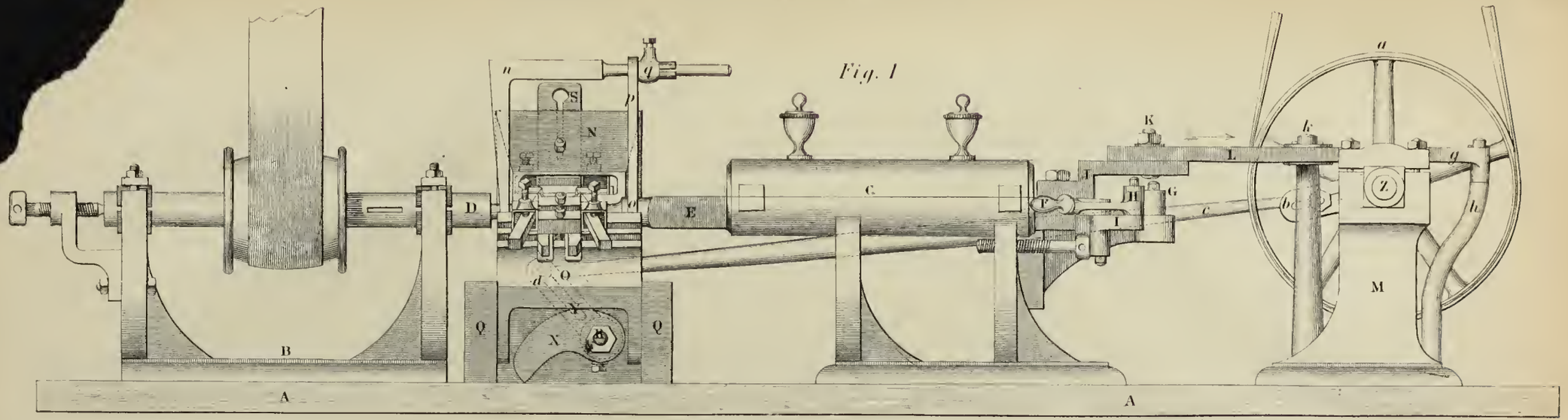
Hackworth's Locomotive.—We shall conclude our remarks on this engine next month, when a plan of the engine, with separate details of the valves, will be given.

G. C., Putney.—His communication will be very acceptable. In the other matter to which he refers, we shall be better able to state what may be done in the way he proposes, after seeing the drawings.

Causes of the Explosion of Steam Boilers.—We have received duplicate copies of this pamphlet, which will be noticed next month.

Britannia Tubular Bridge.—The continuation of these notes is unavoidably delayed until next month.

Fig. 1



Scale 2 ins = 1 ft

Fig. 2.

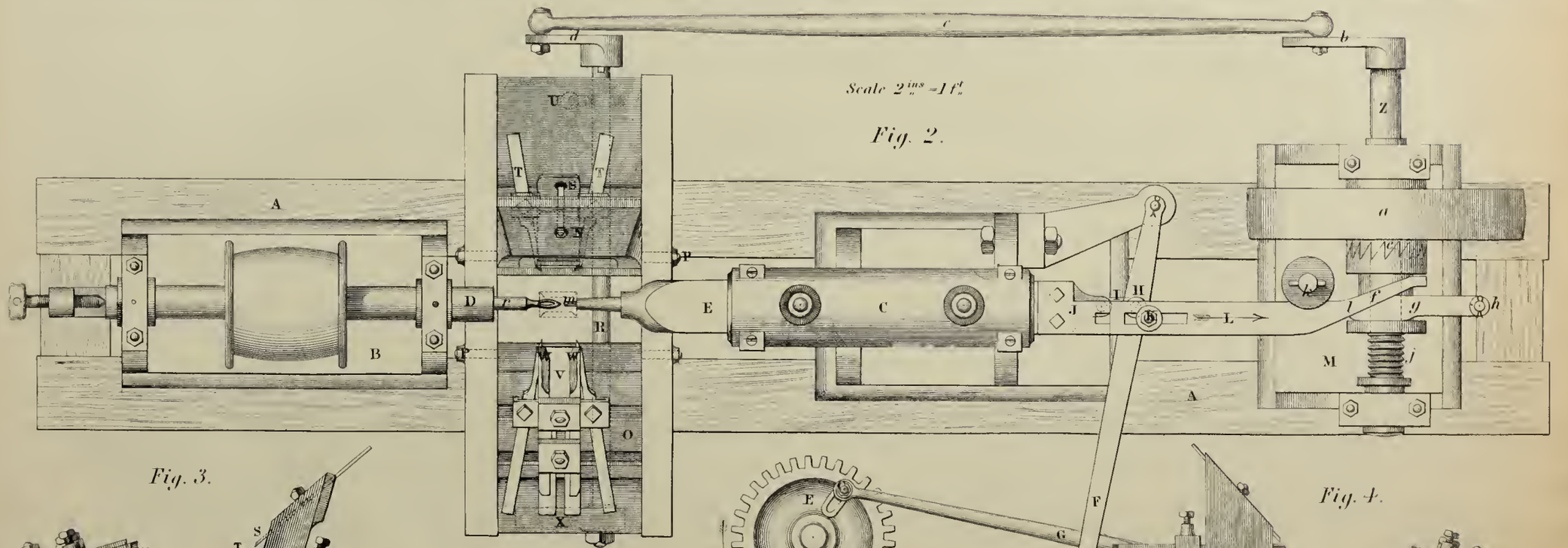


Fig. 3.

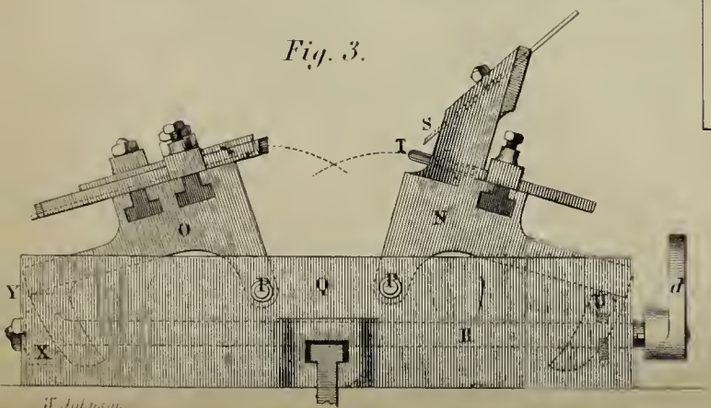
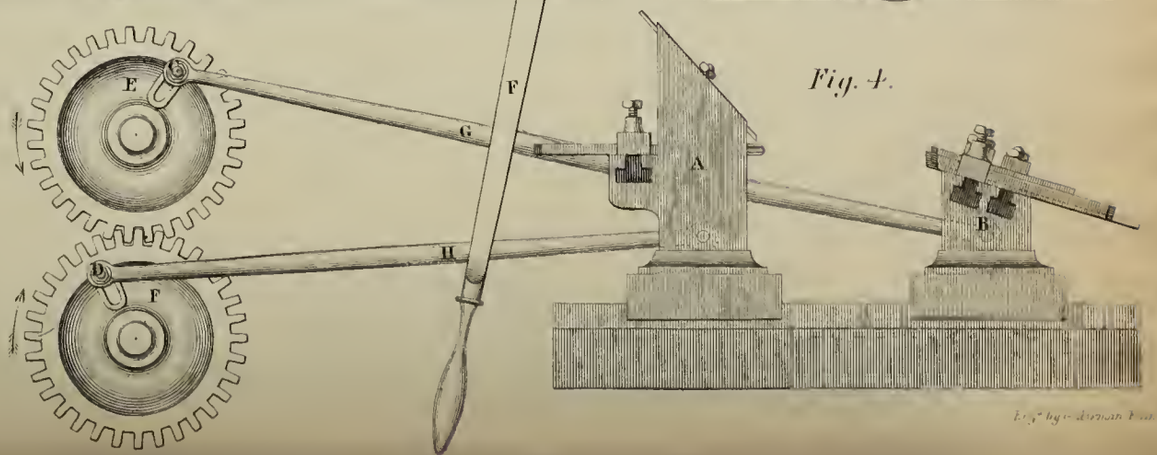


Fig. 4.



W. Johnson,
Patent Office Glasgow

Engd by Gorman Ewan

WORKSHOP ECONOMICS—FINDLAY'S BOBBIN TURNING MACHINE.

(*Illustrated by Plate* 51.)

The sewing-thread factories of Glasgow and Paisley are deservedly numbered amongst the manufacturing curiosities of Scotland, as well for their astonishing extent, as for the regularity and beauty of their operations. Like some other branches of industrial art, thread-making is, unaccountably, almost entirely confined to certain localities; and as Coventry delights in watch-work, and Dundee in flax, so Paisley rejoices in her thread.

A dozen years ago, no lady's work-box, or sempstress's basket, was unaccompanied by a collection of cotton balls, little neatly wound spheres of cotton thread. Now we never see them, and it is with their disappearance that our present chapter on "workshop economics" is most intimately connected, for in the place of the balls, we invariably find a neat range of bobbins, from plain white wood, to the finest ornamental ivory.

The earliest use of bobbins for this purpose occurred some thirty years ago, having originated, as it is said, with a Paisley matron, who sent a few empty bobbins to the late Mr. Clark of Seedhills, to have them filled up at the factory, to save the trouble of the process of hand-winding from the ball. Mr. Clark being struck with the aptness of the notion, set to work to introduce the new plan, by occasionally winding a few bobbins for gratuitous distribution amongst his mercantile friends. At this time the bobbins were all made, as they still are in many rural localities, in an ordinary lathe, with a plain gouge and chisel—the consumption being very trifling. Subsequently, Mr. Clark of Mile-end, Glasgow, an enterprising and extensive manufacturer, introduced turning mechanism, partly self-acting, as a means of increasing the power of production, as the demand for the articles extended. This machinery has been very extensively used under various modifications, and has rendered good service in cheapening what is now a most important item in the thread manufacture. The essential parts of the apparatus most generally employed, were a couple of sliding heads, like those of a small lathe, set upon a slide, so as to move simultaneously upon a short bed, placed transversely upon the workshop bench. At right angles to this bench, and between the two heads, was placed a lathe mandril, carrying the bobbin blank. As this revolved, the sliding heads, one of which carried the roughing, and the other the finishing tool, were traversed back and forward by a lever moved by the hand of the attendant, the roughing tool being brought up to reduce the revolving blank to a plain cylinder, when it retreated to permit the opposite cutter to complete the bobbin. An expert hand-turner, in a good day's work, could produce eight gross of finished bobbins. With the assistance of Mr. Clark's machine, this number was increased to twenty-five gross, whilst the production of the machine delineated in our plate 51, amounts to about sixty gross in a day of ten hours; pretty good evidence of the right of the last-named apparatus to a place in our notes on "workshop economics."

This machine, which is patented in the name of Joseph Findlay, Esq., of the firm of Messrs. W. Clapperton & Co., the extensive thread manufacturers of Paisley, is delineated in plate 51, in four different views.

Fig. 1 is a front elevation of the machine, as fitted on the workshop bench. Fig. 2 is a plan corresponding; and fig. 3 is an end elevation of the cutting mechanism alone. Fig. 4 is a separate detail of another modification of the cutting action.

A A, Is the bench forming the bed of the machine, and carrying the two headstocks, B C, arranged as in an ordinary lathe. The fixed headstock, B, carries the mandril or turning spindle, D, which is driven by a strap pulley in the usual way. On the projecting end of this spindle is a short arbor to receive the rough blank out of which the bobbin is to be formed, as represented in dotted lines. The adjustable headstock, C, carries a sliding centre bar, E, held down in its bearing by a top cap, being moveable longitudinally by the lever, F. This lever has a fixed centre at G, on a bracket bolted to the headstock, and it is jointed at H to the outer end of the bar, E, by a short link, I. The same end of the bar has also bolted to it an angular piece of metal, J, connected at K by a bolt adjustable in a longitudinal slot to the sliding bar, L, acting on the disengaging or stop apparatus on the standard or pedestal, M.

The tool-holders, N O, vibrate on centres at P P, in the plates, Q Q, fixed on the bed between the two headstocks, being actuated by the transverse cam shaft, R. The back holder, N, carries the broad plain chisel or cutter, S, and the two side gouges, T T, which are all bolted down together to form a compound tool, the plain chisel being for turning down the rough blank to the proper diameter, whilst the gouges cut down the ends to the right guage. The stroke necessary to bring this tool into action on the blanks is obtained from a pin or stud, U, adjusted in the shaft, R, so that, at each vibration, the rounded head of the pin presses against the bottom of the holder, raising it up, and causing the tool to traverse the line of the dotted arc.

The front holder, O, is fitted with the cutters for giving the finished shape to the bobbin. The compound tool for this purpose is formed out of five separate chisels, the central plain one, V, being set to cut out the centre cylindrical portion of the bobbin, whilst the two angular chisels, W W, produce the inside bevel of the bobbin flanges, or ends, and the two external chisels cut the outer ends square. The vibratory traverse of this tool is also obtained from the shaft, R, by the cam, X, on its front end, acting at each stroke upon the bottom of the holder at Y. The tool-holders are both worked from the shaft, Z, driven by the pulley, *a*, and carrying a slotted crank lever, *b*, with an adjustable stud-bolt, for receiving the eye of the connecting rod, *c*, which is jointed at its opposite end to a second crank lever, *d*, on the inner end of the cam shaft. In this way, the revolution of the shaft, Z, communicates a continuous vibratory action to the shaft, R, through its longer lever, *d*.

The driving shaft, Z, is fitted with a disengaging or stop apparatus, intended for the purpose of suspending the action of the cutters at the instant of putting in the blanks, or removing the finished bobbins. A serrated clutch piece, *e*, is fixed upon the boss of the loose driving pulley, *a*, and a corresponding clutch is fitted to slide longitudinally upon a feather in the shaft, so as to be capable of engagement with it when required. The angular end, *f*, of the bar, L, projects into the grooved ring of the boss of the sliding clutch, the inclined plane of its front end being made to bear against the loose end of the hinged link, *g*, carried on the top of the standard, *h*. A helical spring, *j*, abuts against the front end of the sliding clutch, tending to keep it constantly in gear with the clutch, *e*, so as to connect the shaft with its driving pulley. When the lever, F, is drawn back to release the finished bobbin from the holder, the bar, L, sliding in the direction of the arrow, bears on one side against the guide-pulley, *k*, as a support, whilst its opposite inclined edge at *l* presses through the link, *g*, upon the front flange of the sliding clutch boss, so as to withdraw the sliding clutch, and disengage the shaft, Z, from the action of its pulley. This movement at once stops the motion of the cutters, giving time for the attendant to place the succeeding blank upon the holder.

In turning thread bobbins by this machine, the rough blanks, properly bored out, are entered upon the short cylindrical end, *m*, of the sliding centre bar, E, which is then traversed forward by the lever, F, to the position represented in the plate. This action forces the contrary end of the blank upon the arbor, as indicated in the plan, fig. 2, where it is held by two slight ribs or projections, so as to be carried round at a rapid rate by the mandril. As previously explained, this movement puts the shaft, Z, into motion, through the bar, L, and the tools approach,

one slightly after the other, to the revolving blank, to reduce it to the required figure of the bobbin.

The vibratory traverse of the two tool-holders is not simultaneous, the back or roughing-off action being brought into play first, so that the finishing cut always acts upon the blank after the latter has been reduced to a plain cylinder. To accomplish this effect, the actuating pin of the plain tool is set to act slightly in advance of the cam of the front finishing tool. At each traverse of the connecting rod, *c*, in the direction of its arrow, the stud, U, rises to its highest point with the vibration of the shaft, raising the tool-holder correspondingly; and the traverse being continued to a short distance beyond this point, the head of the stud descends slightly in its movement, on the opposite side of the axis of the shaft, thus withdrawing the tool, after it has cut, to a distance sufficient to clear the blank. At this point of the action the front tool comes into play, cutting down the recess for the thread, and completing the bobbin, when the movement of both tools is reversed, and the bobbin is removed by the angular bar, *n*, which receives its movement from the bar, E. The latter has attached to it at *o*, an upright bar, *p*, the top of which is bored out, and has a split eye formed upon it, so as to be adjustable by a screw-thread and stud-piece, *q*, upon the end of the angular bar, *n*. The opposite end of the latter has an eye adjusted to slide upon the cylindrical portion, *r*, of the blank-holder, so that each time the lever is drawn back, the end of the bar, sliding on the holder at *r*, presses the bobbin off. The same movement of the lever also stops the vibration of the tool-holders until a new blank is applied, as before.

The object of the self-acting stop-motion of the cutters, is to afford time for the attendant to put on the blanks without risk of accident from the approximation of the cutters at the time that this is done. If the machine is worked without such a movement, the action of the cutters will be at constant regular intervals, and the attendant must time his movements so as to put on the blanks exactly at the moment of the expansion of the tool-holders.

Various modifications of cams are applicable for traversing the tool-holders; and the inventors have, in some instances, employed a cam or eccentric, instead of the crank-lever on the driving shaft, Z, the object being to give the cutters a quick traverse when out of cut, and a slower one while in the act of cutting.

Fig. 4 represents a side elevation of a pair of cutting tools, A B, arranged to traverse along a straight bar by the action of a pair of crank pins, C D, adjustable in slots in a pair of spur-wheels, E F, working in gear with each other. In this arrangement the shaft of the wheel, F, is assumed to be the driver, the upper wheel, E, being driven by it. The pins of the two connecting rods, G H, are so set that the simultaneous revolution of the two wheels in the direction of the arrows, produces a corresponding traverse of the tool-holders in opposite directions. The adoption of the spur-wheel arrangement affords a ready means of setting one cutter to act slightly in advance of the other, by varying the positions of the crank pins in relation to each other. In another arrangement, a right and left cam, fitted on a spindle, underneath the tool-holders, is beautifully adapted to give the traverse motion to the cutting tools, this action being producible in various ways; whilst the disengaging apparatus, with the movement for taking off the bobbin, may be worked by the machine itself, without the hand-lever, if necessary.

By the old hand process, the workmanship of bobbins amounted to about 5d. per gross. Mr. Clark's machine reduced this cost, at one step, to 1½d.; whilst the machine we have just described has brought it down to ¾d. for the same quantity.

In addition to its office as a bobbin turner, the contrivance will be found useful for the production of any of the small turnery articles, of which great quantities of the same kind are required, such as wharves for spindles, small pulleys, or the innumerable ornaments of Tunbridge ware.

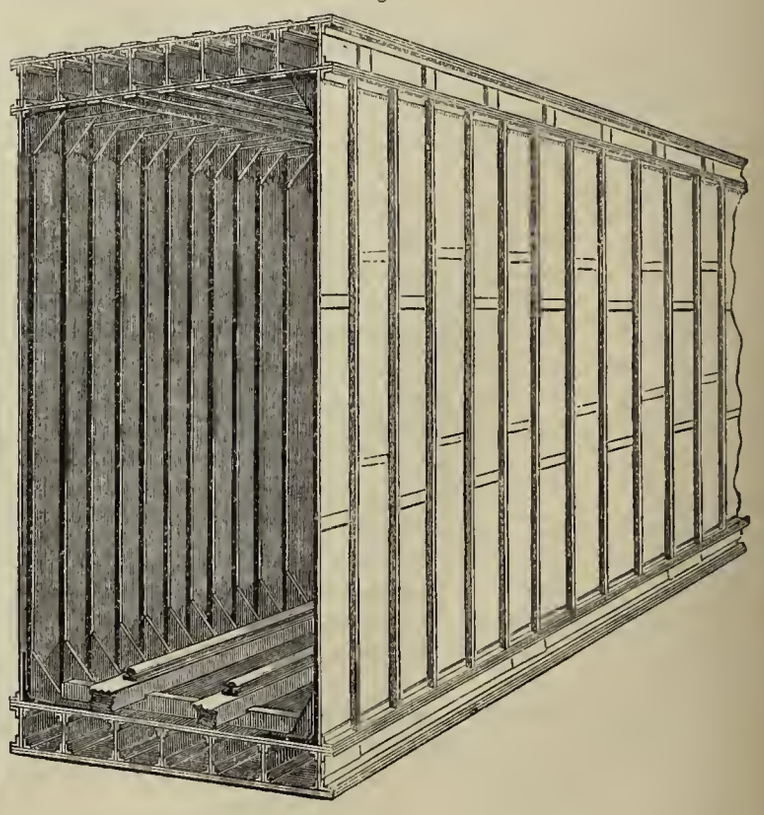
NOTES OF AN EYE-WITNESS ON THE BRITANNIA TUBULAR BRIDGE.

(Continued from page 36.)

In order to insure an ample supply of the plate and angle iron, of dimensions suitable for the tubes, arrangements were made with four of the most extensive iron manufacturing firms,—the Butterley Company, the Coalbrookdale Company, Mr. Thorneycroft, and Mr. Williams; each being bound, under pain of heavy penalties, to deliver their iron within a specified time. The tubes were commenced in July, 1847—the first rivet being driven on the 10th of August following, and by midsummer, 1849, the first tube was completed, in readiness for floating. As a preliminary to the details, we may here recapitulate what was before stated, as to the bridge being made up of two abutments and three intermediate towers, there being thus two openings to span over the water, and two over the land. The waterways are much the largest, being 460 feet in the clear at the level of the tubes, whilst the spaces between the two abutments and the side towers are only 230 feet each; the tubes for the latter are four in number, and are constructed in the places they must occupy when complete, on whole timber scaffolding erected for the purpose, and containing 118,000 cubic feet of timber. The stage on the Anglesea side is upwards of 100 feet high, but the nature of the ground on the opposite shore makes the height there only about 50 feet. The four large tubes for the two water openings were built on staging, erected along the shore of the straits, an allowance of 12 feet being made in the length of each tube, in order to give a bearing on the towers of 6 feet at each end after lifting, and previous to the two being joined end to end by the junction pieces built through or inside the towers,—the extra length being provided for during the lifting, by the grooves in the tower faces.

The completed tube for each line of rail is of the rectangular shape, represented in our perspective sketch, fig. 1, being 1,513 feet in length.

Fig. 1.



The plates of which it is constructed will average half-inch thick, and are united by ribs of T iron, and angle L iron—the joints of the plates being throughout what are termed butt-joints. The end joints are in all cases covered with a short plate on each side, securely riveted to both of the long plates, whose ends they cover. The rule has also been observed, that the sectional area of the two covering plates shall equal that of the plates, whose ends are thus united. In every part of the work where wrought-iron only is used, the material is put together with red-hot rivets, the heads being hammered up by hand, and finished by swaging. Fig. 2 exhibits a complete elevation and plan of the bridge,

drawn to the scale of 240 feet to the inch, and showing the levels of high and low spring-tides.

The extreme height of the tubes at the ends is 23 feet, but on the Britannia tower it is 30 feet, the top being curved to that extent, whilst the bottom is a straight line throughout. The sides are formed of a single thickness of plate-iron, and serve to distribute the load equally over the top and bottom (in which parts the great mass of metal is placed), and also, by connecting both, to give the requisite strength and lightness—this object being gained by the hollow beam form of the tube, the top being adapted to resist compression, and the bottom, extension. It is these portions which demand our praise, for, by their judicious arrangement, these great essentials are secured by the formation of a series of rectangular cells, ranged side by side. The reader may here refer to a transverse section through the centre of one of the tubes, given at page 123, vol. ii.

The detail, fig. 3, represents a portion of the bottom of the tube, exhibiting the cellular structure on a larger and clearer scale: A, are the covering plates; B, the angle irons; C, are the angle irons for fastening the sides to the cellular bottom; and D, are the division plates of the cells. A portion of one of the vertical ribs of T iron is shown at E, and the internal angular or gusset pieces at F, with the iron knee, also formed of T iron, at G; H, is the iron-plate kelson.

The sectional area of the large tube at the centre is made up of the top, 650 square inches; sides, 305; and bottom, 532 square inches. These dimensions give only the actual sectional area for strength—the whole area being taken for the top and sides—whilst in the bottom the rivet-holes are deducted, because, being under a tensional strain, every rivet-hole is so much area lost. The total weight of the tube as floated, with cast-iron frames complete, is about 1,800 tons.

We have now arrived at the description of one of the large tubes for the water openings, as constructed on the staging by the water-side. The space across the waterway, between the dressed masonry of the recesses, is 472 feet, and the tube was made 471 feet 4 inches long, to allow for a little play at each end during the floating and lifting operations. The top of the staging was formed with an upward curve of 9 inches, so as to give the bottom of the tube this amount of upward curvature, to allow for deflection when resting on its ends only, *in situ*.

All the ½-inch plates in the two layers of the bottom, are each 12 feet long, and 2 feet 4 inches wide, the end joints being arranged to break bond, so that the ends of one layer shall always come over or under the centre of some other plate; the joint on the exposed side of the plate having a covering plate 2 feet 8 inches square, as in the detail, fig. 3. Upon this double layer of plates, cells 2 feet 4 inches wide, and 1 foot 9 inches high, are formed, such cells being constructed lengthways of the tube; the two outsides and the central divisions are made of ½-inch plate iron, and the top, which forms also the floor of the tube, is double like the bottom.

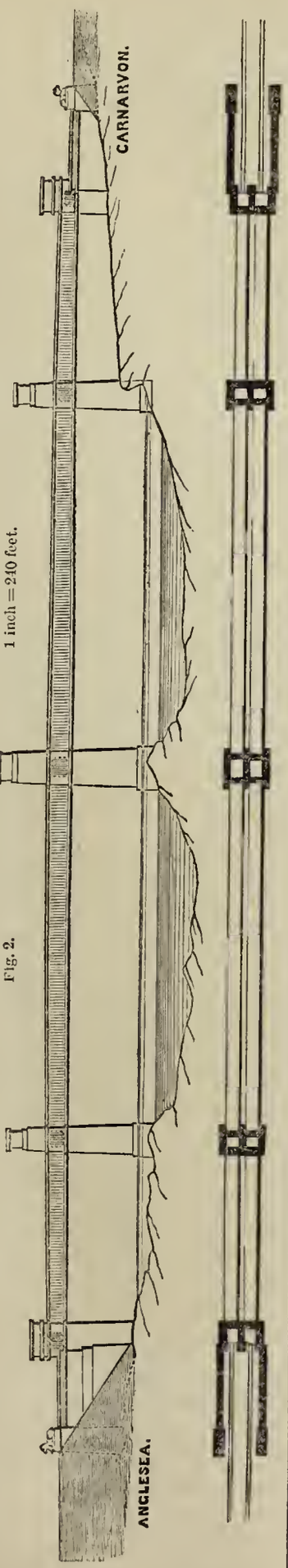
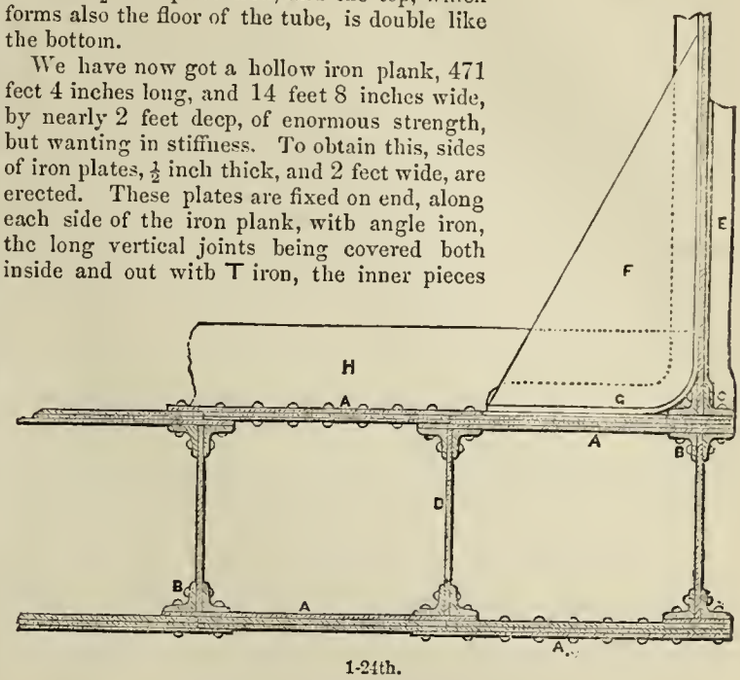


Fig. 2.

We have now got a hollow iron plank, 471 feet 4 inches long, and 14 feet 8 inches wide, by nearly 2 feet deep, of enormous strength, but wanting in stiffness. To obtain this, sides of iron plates, ½ inch thick, and 2 feet wide, are erected. These plates are fixed on end, along each side of the iron plank, with angle iron, the long vertical joints being covered both inside and out with T iron, the inner pieces

Fig. 3.



1-24th.

being sufficiently long for bending at right angles at top and bottom, to form a knee or bracket, further strength being afforded by the addition of the gusset pieces riveted in the angles to the web of the T iron. Above these sides a single layer of plates, 1 foot 9 inches wide, forms the ceiling of the tube, the long joints being covered on the underside with strips of plate iron, 8 inches wide, the ends having covering plates as before.

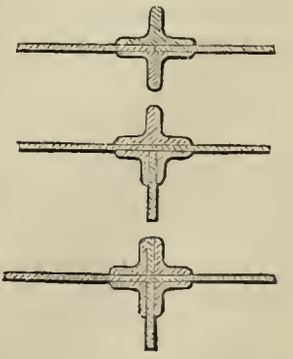
The top row of cells are eight in number, the division and outside plates being 1 foot 9 inches deep, and ¾ inch thick. The top of these cells is made of a single thickness of plate, and the division plates are united to the top and bottom with angle iron; the long joints being covered with 8 inch strips. All throughout the tube, the end joints are secured by covering pieces, so as to make the sections through the rivets equal to any other part.

Transversely, the bottom is stiffened by iron kelson plates, 10 inches deep, placed across the inside of the tube every 6 feet, and riveted to the bottom by angle iron. The top cells are supported and stiffened transversely by plates of the same depth, placed at intervals of 12 feet, and secured as before.

The permanent way through the tube is formed with half-balk longitudinal sleepers, which rest upon the 10 inch transverse stiffening plates; the intervals between the kelson plates at the bottom of the tube being clear for cleaning and painting when necessary. The rails used are of the Great Western pattern.

This description strictly applies only to about 120 feet in the centre of the tube, the remainder being made much stronger in the sides, to enable the tube to retain its shape under the severe strain to which it is exposed upon approaching and passing through the towers. Every sixth T iron inside the tube, beginning at 60 feet from the centre, and extending to within 56 feet of each end, has an additional plate of iron riveted to it; the gusset pieces being also considerably larger than those used at the centre. The remaining length of 56 feet at the ends has inside stiffening pieces of the same character, and also additional outside pieces, both of which occur every 2 feet; angle iron being used in this case, instead of the T iron ribs. The first sketch in fig. 4 shows the section of T iron and plates at the centre of the tube; the second shows the T iron with the internal stiffening piece; and the third, the method employed for strengthening the ends near the towers. The portion of the end of the tube intended to rest on the masonry of the towers, is further strengthened

Fig. 4.



by very stout castings, bolted to the division plates of the bottom cells for 12 feet in length; and the sides, top, and bottom of the tube, are retained in shape by three pairs of cast-iron frames, carefully fitted and bolted to the sides and bottom of the tube. These are 2 feet apart, from centre to centre, the two end pairs being notched on their inner edge to receive three heights of horizontal cast-iron beams, to which the lifting chains were attached. Two pair of these beams had 7 inches space between, to allow the chains to pass through, and were bolted in such a way that they could not open or spread in any way more than the 7 inches required. The chains are of flat bar-iron, each link being exactly 6 feet long, from centre to centre of the bolts, eight and nine bars being alternately used for each link. These bars are 7 inches wide, the section of each link being 63 inches, two such chains being used for each end of the tube. The attachment of the chains to the lifting beams, is made by notching the underside of the beams on the inner edge; and the chain having two shoulders of 1 inch each on each side, to correspond, as in the detail of the link end, fig. 5.

Fig. 5.

1-16th.

The lifting beams are strengthened by a cast-iron column between each tier, in addition to which, two stout wrought-iron diagonal straps are passed from the bottom corners of the tube, and over a saddle resting upon the top beam; one being on the outside face, and the other on the inside of the beams.

On the completion of one length of 471 feet 4 inches of tube, a pier of masonry was built under each end, to support it during the removal of the staging, and until the shore could be excavated to a sufficient depth, to allow of the pontoons being floated underneath to their proper places. These pontoons are large rectangular floats, 98 feet long, 25 feet wide, and nearly 11 feet deep, each being capable of supporting from 400 to 500 tons, and drawing from 5 to 6 feet water when loaded. To float one tube, eight pontoons were considered necessary—six of wood, and two of iron—each being fitted with pumps to clear them of water, with valves for the admission of water when required.

Powerful capstans were fitted to all the pontoons, with the necessary hawser slots for the guidance of the cables, the greater portion of these being of the unusual size of 12 inches circumference. For checking them, an apparatus, termed a cable-stopper, was used. This is formed of two pieces of hard wood, about 8 feet long, each being hollowed longitudinally to a segment of a circle (for the cable to pass through), the two being spanned across the centre by a cast-iron frame, fitted with a powerful screw, one end of which acts against the upper timber, whilst the other has a cast-iron plate fitted on to it, with steps to receive the working capstan bars. When paying out the cable, as it passed through the groove in the wood blocks, it could be checked at pleasure by the screw pressure on the blocks. The great stiffness of large cables under a heavy strain, rendered the use of an apparatus of this kind quite indispensable in this case.

Whilst the preparations for floating were going on under and around the tube, others equally important were in progress along the shores of the Menai Straits, in fixing moorings and capstans at different points, for hauling or checking the tube when on its way from the building site to its final position between the towers. The two most important lines were secured on shore at the end of the tube furthest from the bridge, and passing through the hawser-slots and cable-stoppers on the pontoons, were continued to the Anglesea shore, and attached to two capstans on the opposite side of the bridge. These were termed the "inner" and "outer guide" lines, and served the purpose of guiding the tube to its proper place, the cable-stoppers being chiefly intended for them. The first operation of floating, after the tube had risen from its temporary resting-place with the tide, was the hauling it from its berth by lines fastened on the Anglesea shore, and worked by the capstans on the pontoons. To counteract the too early action of the tide upon the huge mass, a mooring had been laid out in the stream, and to this the end of the tube was secured; a sufficient length of rope being given out to allow the tube to swing clear into the stream, which being done, the tube was allowed to slide along the guide lines, and, as it approached the towers, it was gradually drawn to a proper position for entering the recesses left in the masonry, by the aid of the shore capstans, the final operation of hauling home to the masonry being done by crabs.

Thus was accomplished the first instalment of this mighty work, for and against which so much has been said; many having gone so far as to seriously shake their heads upon viewing the isolated tubes, and confidently prophesy that the floating was impossible. It was a noble sight to see the huge mass, when brought fairly out into the centre of the straits, quietly and gracefully floating to its appointed place, every eye intent upon observing its even and orderly movements, as it yielded to the strains brought to bear upon it; and as it neared its destined place, scarce a whisper could be heard, so absorbed were all in the final result of the throw for immortality made by the great man before them; but upon the announcement being made of "all right," it was a joyous thing to hear the cheers burst from the assembled multitudes, announcing their satisfaction at the success so far attendant upon this great and novel work.

OXYGEN.*

II.

First on our list are the cotemporaries, Robert Boyle and Dr. Hooke; both celebrated for their love of truth, but, in nearly every other respect, differing as widely as possible. Boyle was the attractive, elegant, and insinuating Irish gentleman. Hooke, the cool, cautious, and sarcastic observer. Boyle found ready panegyrists for all his acts, and one of his admirers has for ever immortalized his own lucubration by commencing with the memorable sentence, "Robert Boyle, the *father* of chemistry, and *brother* to the Earl of Cork"—thus making his lordship *uncle* to chemistry; a case of nepotism without a parallel. Hooke was less fortunate, if fortune is to be reckoned by the amount of written praise, for one of his acquaintance thus speaks of him:—"He is very crazy, much concerned for fear he should outlive his estate. He hath starved one old woman already, and, I believe, he will endanger himself to save sixpence for anything he wants." The same friend(?) writing after Hooke's decease, says, "I wonder old Dr. Hooke did not choose rather to leave his £12,000 to continue what he had promoted and studied all the days of his life, I mean mathematical experiments, than to have it to go to those whom he never saw or cared for. It is rare virtuosos die rich, and it is a pity they should if they were like him."

Boyle was born in Ireland in 1627, and died in London in 1691. He repeated Le Brun's experiment of the calcination of tin; and finding that the calyx could not be formed without the assistance of heat, and apparently not noticing that air was also necessary, he adopted the idea that calces were the compounds of heat with the respective metals; the increase of weight being due to the fixation of that amount of heat.† That Boyle should have neglected the action of air is especially remarkable, because he was the first to introduce the air-pump into England, and, by its aid, experimented upon the utility of air in ordinary combustion. He found that gunpowder, in the exhausted receiver, could be ignited by a burning-glass, whereas other combustibles would not inflame; and hence he concluded, that the nitre contained in the powder was concerned in furnishing materials, now known to be oxygen, to supply the place of air.

Dr. Hooke was born 1635, and died 1702. His experimental researches are not his only claims upon posterity, for the inculcation of the sentiments expressed in the following brief quotations from his works, will always demand respect. In his preface to the "Micrographia," he thus warns the lovers of hypothetical speculation:—"In this investigation, upon which the desirable reform in philosophy is to be founded, there is not so much required any strength of imagination, as a sincere hand and faithful eye, to examine and record the things themselves as they really appear."—"The science of nature has been too long made the work of the brain and of the fancy; let it now revert to plain and sound observation; let there be rigour in admitting, strictness in comparing, slowness in debating, and shyness in determining." The understanding "must watch the irregularity of the senses, but not go before them, or prevent their information; it must examine, range, and dispose of the bank which is laid up in the memory; but it must be sure to make distinction between the sober and well-collected heap, and the extravagant ideas and mistaken images which there it may sometimes light upon." Speaking of himself, he says, in the true spirit of a philosopher, *i.e.* a lover of wisdom, "If ever I have ventured at small conjectures respecting the causes of the things I have observed, I beseech the reader to look upon them only as doubtful problems and uncertain guesses, not as unquestionable conclusions, or matters of unconfutable science." We could almost wish to possess the fabled powers of some eastern potentates: we would first cause this sentence to be written in letters of gold, and then would issue an unalterable decree, compelling its hourly repetition by all speculative philosophers, under pain of instant destruction of their unread productions. In the sixteenth section of the same work,

* Concluded from page 59, June 1.

† If it be said that heat and phlogiston are here synonymous, it must be remarked, that if it be so, then Boyle must have reversed the phlogiston theory: he says, metals during calcination combine with heat (phlogiston?); the theorists said, by calcination a body became dephlogisticated, *i.e.* it was deprived of phlogiston (heat?).

he uotices the necessity of the presence of air in common comhustion. In its absence, wood is converted into charcoal, wbich glows hut does not burn. He argues that air is the universal solvent of combustible bodies. The term "solvent" heing employed, we suppose, in the same sense as applied to air when it is said to dissolve water by evaporation; that is, in a state of very intimate mechanical mixture or adhesion, and not in that still closer connection which is now conceived as chemical combination: for all chemical operations, such as the formation of salts and alloys, were generally explained mechanically, and were even definitely assigned to the peculiar effects of certain arrangements of hooks and eyes, clefts and wedges, and similar eontrivances. Hooke, in further illustration of this solvent power, says, that it is exercised only by a small proportion of air, which is like unto, or the *very same*, as that which is fixed in saltpetre, oxygen; and hence the atmosphere is like those spirits (spirits then signified many things hesides alcoholic liquids, thus the acid solvents of the metals were termed spirits, as, spirits of salt and of nitre, suhstances now known as hydrochloric and nitric acids, &c.,) which have much phlegm, impurity, in them, and soon hecome glutted, whereas saltpetre abounds more in those solvent particles, and hence a little will dissolve a great sulphureous hody quickly and violently; and as otber weak solvents will quickly consume the dissoluhle body if applied in sufficient quantity, so air applied to a combustible, hy a draught or by bellows, will dissolve it as rapidly as saltpetre. Whence, he concludes, there is no element of fire, hut that flame is the result of the *mutual* agency of the combustible and part of the atmosphere. He also particularly alludes to the use of air in respiration, but does not appear to have followed up these investigations. In a later work, "Lampas," 1677, he explains, in a very heautiful manner, the phenomenon of the flame of a candle; and by holding in it a thin piece of glass or mica, he ohserved its section, and showed tbat the interior is not luminous. Hooke's doctrines were also independently illustrated by John Mayow, born in Cornwall, 1645, died in London, 1679. At least Mayow never names Dr. Hooke, and we must therefore, in the absence of proof to the contrary, charitably suppose that he was unaware of Hooke's labours. Mayow's views on respiration are particularly remarkable as being the first which are worth reviewing. He experimented by placing a hurning candle and a living mouse under similar bell-glasses, and noting the duration of flame and life thus situated. He then placed a candle and mouse together under the same hell-glass, and found tbat life and flame were extinct in a proportionally shorter interval of time. He also varied the experiment by endeavouring to burn a candle in air spoiled by breathing, and to support life in air vitiated by combustion. Failing in both instances to maintain either flame or life, he concluded, "that the nitro-aerial particles are absorbed both by tbe candle and by the animal." The then prevailing theory ascribed to respiratiou tbe property of cooling the blood; but having observed the necessity of the "fire-air" particles in ordinary combustiou, he considered tbeir absorption as nccessarily counected with tbe heat of tbe blood.

Dr. Stephen Hales, born in Kent, 1677, died at Teddington, 1761, may be said to hc the first who fairly laid the foundation of pneumatic chemistry, the chemistry of the gases. Mayow and others hewed and dressed many stones, hut Hales laid the foundation, and Priestley afterwards raised thc scaffold, and devised implemcnts for future use. The building is still unfinished, aud honest hard-working labourers are in request; we might venture to say thcrc are also good openings for good architects.

Hales' experiments are exceedingly curious, and bis conduct well exemplifies the dangcr of a strong adherence to a mere theory. He had started with the idea that all gases were only so many modifications of common air, and thougb he actually procured hydrogen, coal gas, oxygen, and carbonic acid gas, as well as many others, yet hc contented bimself by measuring their quantities, and took no beed of their remarkable and distinetive properties. He also observed that calcined tartar, containing much caustic potash, partially purified air tbat had been spoiled by breathing; but iustead of dctecting its specific actiou, its comhining with the carbouic acid gas, he confounded it with thc mere absorbing powers of some other kinds of salts. In faet, no man was ever nearer thc discovery of important truths, and so wilfully neglected his opportunities. A fatality appears to have attached itself to all hc did. It was the fatality of seeking facts to establish a theory, instead of contentedly accepting facts for tbeir own sake, until they should embody forth tbeir own theory of truth. It was the dog and the shadow—hypothesis against induction; and we are almost led to believe that Hales must have originated the saying, which has heen, perhaps, rather too vain-gloriously generally ascribed to a foreigner—"If facts do not agrec with my theory,—why, so mueh the worse for the facts."

But it was Priestley's discovery of oxygen, on the 1st of August, 1774, that completed the overthrow of thc phlogiston thcory. He procured the gas by concentrating the sun's rays upon a quantity of thc red precipitatc of mercury, which was placed in a glass flask filled with, and inverted in, quicksilver. "I presently found," says he, "that by means of this lens, air was expelled from it very readily. Having got several times as much as the bulk of my materials, I admitted water to it, and found that it was not imhihed by it. But what surprised me more than I can well express, was, that a candle hurned in this air with a remarkably vigorous flame, very much like that enlarged flame witb which a candle burns in nitrous air exposed to iron or liver of sulphur; but as I got nothing like tbis remarkahle appearance from any kind of air besides this particular modification of nitrous air, and I knew no nitrous acid was used in the preparation of thc *mercurius calcinatus*, I was utterly at a loss how to account for it." It is scarcely possible to refer to a more simple and truthful account of a great discovery; and the spirit of the following short extract from his own prefatory remarks, coincides so well with our own views, that we cannot refrain from taking this opportunity of inserting it:—"The contents of this section will furnish a very striking illustration of the truth of a remark which I have more than once made in my philosophical writings, and whieh can hardly be too often repeated, as it tends greatly to eneourage philosophical investigations, viz., that more is owing to what we call *chance*, that is, philosophically speaking, to the observation of *events arising from unknown causes*, than to any proper design or preconceived theory in this husiness. This does not appear in the writings of those wbo write synthetically upon these suhjects, but would, I doubt not, appear very strikingly in those who arc the most celehrated for their philosophical acumen, did they write analytically and ingeniously."—(Exp. and Obs., vol. ii. p. 103.) The danger against which he warns us—trust in theory—was one which overcame himself. By his natural powers of observation, aided by great energy and untiring perseverance, hc made discoveries that overthrew existing tbeories, and laid for science a solid foundation of facts; yet he himself named this newly-discovered gas "dephlogisticated air," and tenaeiously adhered to the title even after its properties and actions had become much better understood. Despite constantly accumulating evidence, he continued to fight under the banners of the phlogistians, and almost his last publication was a traet entitled, "The doctrine of Phlogiston established, and that of the Composition of Water refuted." He first made the eudgels, and after placing them iu vigorous and unsparing hands, deliberately laid himself out for castigation. His life and charaeter are so remarkahle, and afford so many points for reflection to all would-he philosophers, that we purpose noticing his career at some length. His many hrilliant discoveries, that of oxygen heing only one amongst many, although it is tbe one with which we are at present most concerned, his contrivances for the readier prosecution of pneumatic chemistry, and many other labours of scientific research, entitle him to our very highest regards. "To err is human," and we should merely look upon his faults as heacons for oursclves; for it will always be a suhject of admiration, and an ample excuse for bis defeets, that amidst all the persecutions and turmoils of political and theological party controversies, he still found time for the successful pursuit of philosophical experiments; and thus removed the exeuse of every one, who, in palliation of their short-comings in the same labours, would plead the idler's refuge, "want of time."

Joseph Priestley was born at Fieldbead, near Leeds, in 1733. Educated by his aunt with a view to his assuming the funetions of a Unitarian dissenting clergyman, in early life he made very considerable progress in the dead languages, Latin, Greek, and Hebrew; but from failing health, he was advised to turn his thoughts to trade, and to settle at Lishon. He therefore applied himself to the modern languages, and learned, as far as possible, French, Italian, and German, without a master. Returning strength brought with it a desire to carry out his first intention of entering the ministry, and accordingly he completed his academical studies at Daventry. He studied keenly, and from the peculiar position of the academy, freedom of discussion being allowed and encouraged to its full extent, and the two masters espousing different opinions, be became, almost necessarily, both well skilled in, and much addicted to, controversial subjects, and apt in maintaining his own speculative opinions. His studies not only embraced the ordinary course relating to theology and divinity, hut included mechanical philosophy and metaphysics, and some knowledge of Chaldee, Syriac, and Arahic. On leaving the academy, he became assistant in a small meeting-bouse at Needham, from which he never received more than £30 a year. His theological opinions drove away his hearers, and still further diminished his income. He attempted to open a school; but the odium attached to his tenets prevented his success, and at length he became indebted for the means of suhsistence to the aid of charitable funds procured through Drs. Benson and Kippis. His unpopularity placed all the vacant situa-

tions in the neighbourhood beyond his reach, and nearly every one treated him with contempt; but when in after years the then popular Dr. Priestley came to preach in that locality, the chapels were thronged with those who eagerly flocked to hear the same sermons which they had in former days so unequivocally and so bitterly condemned. He at length succeeded in obtaining a meeting-house at Nantwich, in Cheshire, where he met with a better reception, doubtless in some measure owing to his careful avoidance of controversial subjects. He opened a school, and found it both agreeable and profitable; and he employed his leisure time in giving private lessons in the house of a neighbouring and eminent attorney. He was able to procure books and a few philosophical instruments, wrote a grammar for the use of his school, and even found time to learn to play a little on the flute.

The Warrington Academy had been founded during his stay at Needham, and on a vacancy occurring in the office of tutor in the languages, he was invited to accept it, and accordingly left Nantwich for that purpose. He there, at Warrington, wrote his "History of Electricity," which first brought him into note as an experimental philosopher, and enabled his friends to procure for him the title of Doctor of Laws from the Edinburgh university. From quarrels between various parties connected with the institution, he was induced to leave it, and, in 1767, accepted an invitation to take charge of Minhill chapel, at Leeds, where he had ample leisure to pursue his favourite studies, and produced numerous works, many of them controversial. His chemical career was likewise commenced at Leeds, and he was accidentally led to think of pneumatic chemistry by witnessing the operations at a brewery near his residence. After six years' residence in Leeds, the Earl of Shelburne, afterwards Marquis of Lansdowne, engaged him as librarian and literary companion, at a salary of £250 and a house. It was during this engagement that he made his celebrated discovery of oxygen. In company with his lordship, he visited the continent, travelling through Holland, France, and Germany, and residing some time at Paris. In the course of a few years, Priestley and Lord Shelburne separated by mutual consent; and, in accordance with a previous stipulation, his lordship settled upon him an annuity of £150, which was regularly paid during the remainder of Priestley's life. To add to his diminished income, several of his friends, headed by Dr. Fothergill, raised a subscription to enable him to carry out his experiments to their full extent. He then settled at a meeting-house in Birmingham, and pursued his theological and chemical investigations with increased ardour. He completed former philosophical works, continued his periodical, "The Theological Repository," published numerous tracts in support of his peculiar opinions, and upon the history of the primitive church. At first he gained great popularity, but he unluckily ventured to attack the Established clergy of the place, and expressed his political convictions with a force and vehemence that were particularly unsuited to the troubled times of the French Revolution, and especially opposed to the avowed maxims of Mr. Pitt and his administration.

Priestley answered Mr. Burke's book on the French Revolution, and thus incurred the enmity of that extraordinary man, who, in the House of Commons, repeatedly inveighed against his character and writings with peculiar virulence. The clergy of the Church of England also leagued against him, and were joined by his political opponents, now his mortal enemies; for, educated in controversy, he was scarcely prudent in debate, and endangered the success of his cause by unsparing vehemence. This agitation soon produced its fruits. In 1791, on the day of the anniversary of the French Revolution, the populace burned down his meeting-house and residence. They cast his library, manuscripts, and apparatus, into the incendiary flames. His son owed his life to the forcible restraint of a friend. The dwellings of his friends were sacked, burned, and plundered, and he made his escape to London in disguise. He was invited to succeed Dr. Price at a meeting-house at Hackney, but so great was the dread of his unpopularity, that no one would let him a house for fear of its destruction by the mob. And so far was this feeling carried, that, although a "Fellow," yet the members of the Royal Society drove him from their company, and compelled him to withdraw his name. Such was the persecution of opinion in England during the last ten years of the eighteenth century! True those opinions were distasteful to the multitude, and were advocated strenuously and vehemently in the full and bitter spirit of party controversy; yet they were received with tenfold more disgraceful alarm. Fear, hatred, and malignity, all rose up in arms against him. The members of the Established Church procured a bishopric for Dr. Horsley, who, in their opinion, had completely refuted Priestley's theological arguments; yet they still feared the effect of his writings, notwithstanding the so-called victory of their well-rewarded champion.

It is always thus with religious and political ultra zeal. Most sectarians preach, few practice, universal toleration. Political differences, too, frequently lead to enmity. So also in scientific disputes. Opponents lose their tempers, special pleading succeeds to plain statements of facts, acrimony and recrimination hide all beneath a cloud of passion, and the subject of the search is buried in the dust of the debate.

Priestley eventually emigrated to America, where he was received with much respect, and established himself in Northumberland, 130 miles from Philadelphia, and gradually resumed his former pursuits, and, as an almost necessary consequence, created fresh enemies, and so lost ground in popular esteem as to be threatened with expulsion as an alien. Matters, however, did not proceed to extremities, Priestley's forbearance helping to allay the whirlwind; and he died in America, having the pleasure of finding respect for his energy and perseverance gradually on the increase during his latter years. Had he been less controversial; had his mind been less ready to defend its theoretical positions; in short, had he possessed more of the calm deliberative equity of the judge, and less of the one-sided animus of the special pleader, he would have employed his own discoveries in the cause of truth,—would have laid the science of chemistry under far greater obligations than any other man could hope to do, and would have raised himself to a pinnacle of fame unattained by any other philosopher. All this was hindered by his habit of argument. We cannot too often remember that our search should be truth, and that only. Victory in debate may be defeat in reality; acuteness, importunity, or tact, may silence a less able adversary, who, though unapt at rejoinder, may yet have right on his side. The habit of mere discussion, or rather of debate, led Priestley to maintain what he should have calmly considered. It was he who discovered the method and provided the tools, but left it to others to employ them, and, so to speak, enrolled himself an antagonist to the children of his own brain.

Antoine Laurent Lavoisier, working but little in the quarry, became the architect of other men's labours. He may be said to be the first who systematically* applied the balance to the result of chemical experiments, and thus established a judge whose faculties are never unduly influenced. The impetus this gave to science has never been lost, but it continues to move with a constantly accelerated velocity. Lavoisier was born in Paris, in 1743, and fell a victim to the Revolution in 1794. His theories of combustion and acidification have been already referred to, and, though imperfect, they will always redound to his honour. He unfortunately proclaimed himself the discoverer of oxygen, and thus laid himself open to severe and deserved animadversion. Priestley, while at Paris, mentioned his discovery at a philosophical meeting at Lavoisier's table; and mentions this circumstance in his last publication, and so corroborates his assertion by various facts, that we can only lament that so eminent a man as Lavoisier should have descended to such meanness.

Lavoisier's theory, or "the French Chemistry," as it was called, in claptrap patriotism, by Fourcroy, born at Paris, 1755, died 1809, has been so often unduly praised, that, while we admit our debt to Lavoisier for his eminent ability in logical induction from facts ascertained by others, and for his skilful reviews and dissection of hypothesis, we cannot refrain from quoting the following paragraph from Brande, and with it shall close our present essay:—

"The prominent features of the French theory are its explanation of the phenomena of combustion and acidification, the presence of oxygen being deemed essential in both cases. That air is the food of fire was known in the remotest ages; and that it causes the increase of weight sustained by metals during their fusion and calcination, was shown by Rey early in the seventeenth century; that a part only of the atmosphere is concerned in the support of flame, was explained by Hooke in 1667; and that the vital or igneous spirit, as he terms it, of the atmosphere, is concerned in the formation of acids, was asserted by Mayow in 1674. Here, without advancing into the eighteenth century, we have, in explicit detail, all the facts and arguments necessary for the construction of the French theory; but if to these we add the discovery of oxygen by Priestley, and of the composition of water by Cavendish and Watt, what then becomes of its claim to originality?" D.

A SCHEME OF A RATIONAL CLASSIFICATION FOR THE SCIENCES.

II.

We will now proceed to a determination of the principal subdivisions, of which each of these two grand classes of physical science is, according to the same rule, susceptible. Still adhering to the order of the generality and dependence of phenomena, we shall see that Inorganic

* Its application was first suggested by Bergmann, who was born in Sweden in 1735, and died 1784.

Physics must he divided into two sections, accordingly as the general phenomena of the universe, or the phenomena of terrestrial bodies, are contemplated. Hence celestial physics, or astronomy, whether geometrical or mechanical; and terrestial physics. The uecessity of this division is exactly similar to that of the preceding.

Astronomical phenomena being the most general, simple, and abstract of all, it is evident that the study of physical science should hegin with them, since the laws to which they are ohedient exert an influence upon those of all other phenomena, and yet of these latter they are themselves essentially independent. In all the phenomena of terrestrial physics, the general effects of universal gravitation first strike us, and then other circumstances peculiar to this class of phenomena modifying the former. Hence, when we analyse the most simple terrestrial phenomenon, not merely in the province of chemistry, but also of mecbanics, we constantly find it more composite than even the most complex celestial phenomenon. Thus the simple motion of a heavy body—a solid only being considered—really presents, if we would examine all the governing circumstances, a subject of more complex research than the most difficult astronomical question. This clearly shows how indispensable it is to make a clear separation between celestial and terrestrial physics, and not proceed to the study of the second until after the first, the real basis of the other.

Terrestrial physics, in its turn, is subdivided into two distinct portions, accordingly as bodies are mecbanically or chemically considered. Hence physics, usually so termed, and chemistry. The latter, to be taken in a manner really methodical, evidently supposes a previous acquaintance with the former: for all chemical phenomena are necessarily more complicated than the phenomena of physics—they depend upon, without influencing the latter. Every one knows that all chemical action is first subjected to the influence of gravity, heat, electricity; and then, that the action of these agents is modified by something peculiar. This plainly shows that chemistry can only come after physics; and, moreover, that it is a distinct subject: for whatever opinion we may entertain of chemical affinities, and although we should believe that they are only modifications of gravity occasioned by the figure and arrangement of the parts, still the necessity of paying regard to these peculiar properties will not allow us to consider chemistry simply as a branch of, or appendix to, physics. We should, therefore, be compelled, in all cases, were it only for the facility of study, to maintain the division and the connection which at the present day we regard as belonging to the heterogeneity of the phenomena.

Such, then, is the rational arrangement of the chief branches of science relating to inorganic bodies. An analogous division obtains in like manner in the sciences relating to organic bodies. All living beings present two classes of phenomena essentially distinct—those relating to the individual, and those relating to the species, especially when its members are social. It is principally in reference to man that this distinction is fundamental. The last class of phenomenon is clearly more complex and special than the first; the latter depend upon, without influencing the first. Hence the two grand sections of organic physics—physiology, and social physics—the latter being based upon the former.

In all social phenomena, we first notice the effect of physiological laws influencing the individual, and then something besides, which modifies their effects, and which binds the acts of the individual together, singularly complicated in the human race, by the action of each generation upon that which succeeds it. It is therefore evident, that, for the convenient study of social phenomena, we must start from an acquaintance with the laws relative to individual life. On the other hand, this necessary subordination by no means compels us, as some eminent physiologists have been led, to believe, that social physics is simply an appendix to, or a branch of physiology. Although the phenomena are certainly of the same kind, they are not identical, and the separation of the two sciences is of fundamental importance; for it would he impossible to treat the study of the species as a pure deduction from that of the individual, because the social conditions, which modify the action of physiological laws, are there precisely the most essential consideration. Thus social physics must be based upon direct observations proper to it, always having a proper regard to its close connection with physiology.

It would be easy to establish a perfect symmetry between the division of organic physics, and that hereinbefore laid down with reference to inorganic physics, remembering the common distinction between vegetable and animal physiology. In fact, we might carry this subdivision into the principle of classification which we have constantly pursued, since the phenomena of animal life are generally more complicated and special than those of vegetable existence. But to search after this precise symmetry would be somewhat puerile, if it lead us to misapprehend or to exaggerate the real analogies or differences of phenomena. Now, it is certain that the distinction between vegetable and animal physiology, which has a great importance in what I have termed *concrete physics*, has scarcely any in *abstract physics*, to which alone I wish to direct attention in this work. The knowledge of the general laws of life, which ought to be in our eyes the true object of physiology, demands the simultaneous consideration of the whole chain of organic existence, without reference to the distinction between animals and vegetables—a distinction, moreover, which is being gradually effaced as the phenomena receive a closer study.

The result, therefore, is, that positive philosophy is naturally divided into five fundamental sciences, the succession of which is determined by a necessary and invariable subordination, based, independently of any hypothetical opinion, upon a simple comparison of the respective phenomena. These are—astronomy, physics, chemistry, physiology, and, lastly, social physics. The first contemplates the most general, simple, and abstract phenomena; those, at the same time, the most removed from man. They exert an influence upon others without being themselves influenced. The phenomena contemplated by the last, are, on the contrary, the most special, complicated, concrete, and most directly interesting to man. They depend more or less upon all the preceding, without exerting any influence upon them. Between these two extremes, the degrees of speciality, complication, and personality of the phenomena go on gradually increasing, as well as their successive dependence. Such is the general intimate relation which true philosophical observation, employed in place of vain and arbitrary distinctions, leads us to establish amongst the different fundamental sciences.

I have not been able to do more than sketch an exposition of the principal considerations upon which this classification rests. In order to understand it perfectly, we ought, after surveying it from a general point of view, to examine it with reference to each fundamental science. But such a work would be out of place here, where I especially desire that we should occupy a station commanding only the most general views of positive philosophy. Nevertheless, in order that the importance of this classification may be appreciated as completely as possible, I shall here rapidly mark its most essential general properties.

And, first, it has to be noticed, as a decisive test of the accuracy of our classification, that it essentially conforms with the co-ordination, in some sort spontaneous, which is implicitly admitted by the philosophers devoted to the study of the different branches of physical science. It is a condition usually neglected by the framers of encyclopædical plans, that of presenting, as distinct, the sciences which the human mind has been led, without premeditated design, to cultivate separately, and of establishing amongst them a subordination conformable to the positive relations manifested by their development from day to day. Such a relation is, nevertheless, the surest mark of a good classification, because the divisions, which are spontaneously introduced into the scientific system, have been determined solely by long-felt wants of the mind. But, although the classification now proposed fulfils this condition, it is not to be concluded that modes of division, which philosophers are at this day accustomed to adopt in practice, render any of our attempts useless. They have only rendered possible such an operation which presents the fundamental difference between a rational conception and a purely empirical classification. Besides, this classification is not generally comprehended, appreciated, and pursued with all the requisite precision; and, to be convinced of this, it is enough to consider the grave infractions of this encyclopædic law which are daily committed to the great injury of the human mind.

A second essential character of this classification is, that it necessarily conforms to the order of the development of physical science. It verifies all that we know of the history of the sciences, particularly in the two last centuries, when we can trace their progress with greater accuracy.

It is easy to understand that the rational study of any fundamental science, requiring a previous acquaintance with all those that precede it in our arrangement, could only make a real advance, and assume its true character, when the anterior sciences, connected with the most general and abstract, the least entangled with, and the most independent of, others, should have received an extensive development. It is, therefore, in this order that progression, although simultaneous, must take place. This consideration seems to me of such importance, that I do not believe it is possible thoroughly to comprehend the history of the human mind without having regard to it,—the general law ruling, that history cannot be properly understood unless we combine it in its application with the encyclopædic formula just laid down; for it is in the order announced by that formula, that the several scientific theories have successively reached the supernatural state, the metaphysical state, and, afterwards, the positive state. If in practice we do not keep in view the law of this necessary progression, we shall constantly meet with difficulties appearing to be insurmountable; for it is clear, that the supernatural or metaphysical state of certain fundamental theories must temporarily coincide, and has, in fact, coincided, with the positive state of those which are anterior to

them in our encyclopædic system, and thus an obscurity is thrown over the general law, which nothing except the preceding classification can dissipate.

In the third place, this classification possesses the very remarkable property of exactly denoting the relative perfection of the different sciences, which perfection essentially consists in the degree of precision of our knowledge, and in its more or less intimate co-ordination. Indeed, it is easy to see that the more phenomena are general, simple, and abstract, the less they depend upon others, and the more the sciences to which they relate can be rendered exact at the same time, that their co-ordination can be more complete. Thus organic phenomena less admit of an exact and systematic study, than phenomena relating to inorganic matter. And, in like manner, in inorganic physics, the celestial phenomena, considering their great generality and their independence of all others, have given rise to a science much more exact and coherent than that of terrestrial phenomena.

This observation, which strikes every scientific student, and which has often given occasion to chimerical hopes or unjust comparison, is completely explained by the system which I have laid down. Hereafter I shall have occasion to show, that the possibility of applying to the study of phenomena the mathematical analysis which is the means of procuring to this study the highest possible degree of precision and co-ordination, is exactly determined by the rank which the phenomena occupy in my system.

I cannot pass to another consideration without putting the reader on his guard with respect to a very grave but common error. It consists in confounding the degree of precision which the different branches of scientific knowledge allow of, with their degree of certainty, and from this confusion flows the very dangerous assumption that the first, being evidently very unequal, the second must be so likewise. Thus, mention is often made still, though less than formerly, of the unequal certainty of the different sciences, and hence an argument for neglecting the most difficult was deduced. It is clear, nevertheless, that precision and certainty are two properties quite distinct. An absurd proposition may be extremely precise: as, if it were asserted that the sum of the angles of a triangle is equal to three right angles; whilst a proposition positively certain may only allow of a moderate degree of precision, as, for instance, when we affirm that all men will die. If, then, after the preceding explanation, the different sciences must necessarily present unequal degrees of precision, it by no means follows that they have unequal degrees of certainty. Each of them can present results as certain as those of any other, provided that it can combine with its conclusions that degree of precision which the corresponding phenomena permit of—a condition which is not always very easy to fulfil. In any science, all that which is simply conjectural is only more or less probable, and the probable is not its true province; all that is positive—that is to say, based upon well-ascertained facts—is certain; there is no distinction in this respect.

Finally, the most interesting property of our encyclopædic formula, on account of the importance and multiplicity of the immediate applications, is the determination of the true general scheme of a scientific education entirely rational. It is plain, that before undertaking the methodic study of any one of the fundamental sciences, we ought to have prepared ourselves by an examination of those relating to phenomena having an earlier place in our encyclopædic arrangement, because these exercise a preponderating influence upon those whose laws we propose to examine. This consideration is so striking, that, in spite of its extreme practical importance, I shall here confine myself to remarking, that if it is applicable to general education, it is more particularly so with respect to the education of scientific men.

Thus, those devoting themselves to physics, who have not previously made themselves acquainted with astronomy, at least in its general principles; chemists who, before undertaking the study of their own science, have not studied astronomy, and then physics; physiologists who have not prepared themselves for their own peculiar labours by a preliminary study of astronomy, physics, and chemistry, have omitted one of the fundamental conditions of their intellectual development. The same reproach may be made against those who devote themselves to the positive study of social phenomena, without having first acquired a general acquaintance with astronomy, physics, chemistry, and physiology. Up to our day, such conditions have rarely been complied with, and there is no institution regularly organized for that purpose. It may be safely asserted, therefore, that scientific men have not received a truly rational education. This consideration is of such importance in my eyes, that I do not hesitate to impute, in part, to the defects of our present system of education, the state of extreme imperfection in which we still see those sciences which involve the greatest difficulties, a state below that which the more complicated nature of the respective phenomena actually prescribes.

With respect to general education, this condition is still more necessary. I think it so indispensable, that I regard scientific instruction as incapable of realizing the most essential general results which it is destined to bring about in society, for the renovation of our intellectual system, until the different principal branches of physical science are studied in their appropriate order. Let us not forget, that in almost all minds, even in those of the highest class, ideas are connected in the order of their original acquisition; and, consequently, that not to have begun at the beginning is an irremediable evil. It is only a very small number of thinkers that each century sees able, when they obtain their intellectual manhood, to erase early impressions from the table of their brain, (as did Bacon, Descartes, Leibnitz,) and to reconstruct, from base to summit, the entire system of their ideas.

The importance of our encyclopædic law as the basis of a scientific education, can only be properly appreciated after considering it also with reference to method, instead of surveying it solely with reference to doctrine, as we have just done. Under this new point of view, a due execution of the general scheme of study which we have described ought to result in procuring us a perfect knowledge of the positive method, which could not be obtained in any other way.

Natural phenomena having been arranged in such a manner, that those which are really of the same kind are embraced by the same branch of study, whilst those which have been made part of other studies are of a different class, it must necessarily result that the general positive method will be constantly modified in a uniform manner whilst pursuing the same fundamental science, and that it will receive various modifications more and more composite in passing from one science to another. We shall thus be certain of considering it in all the varieties of which it is susceptible; but this would not have been the case, if we had adopted an encyclopædic formula which did not fulfil the essential conditions before laid down.

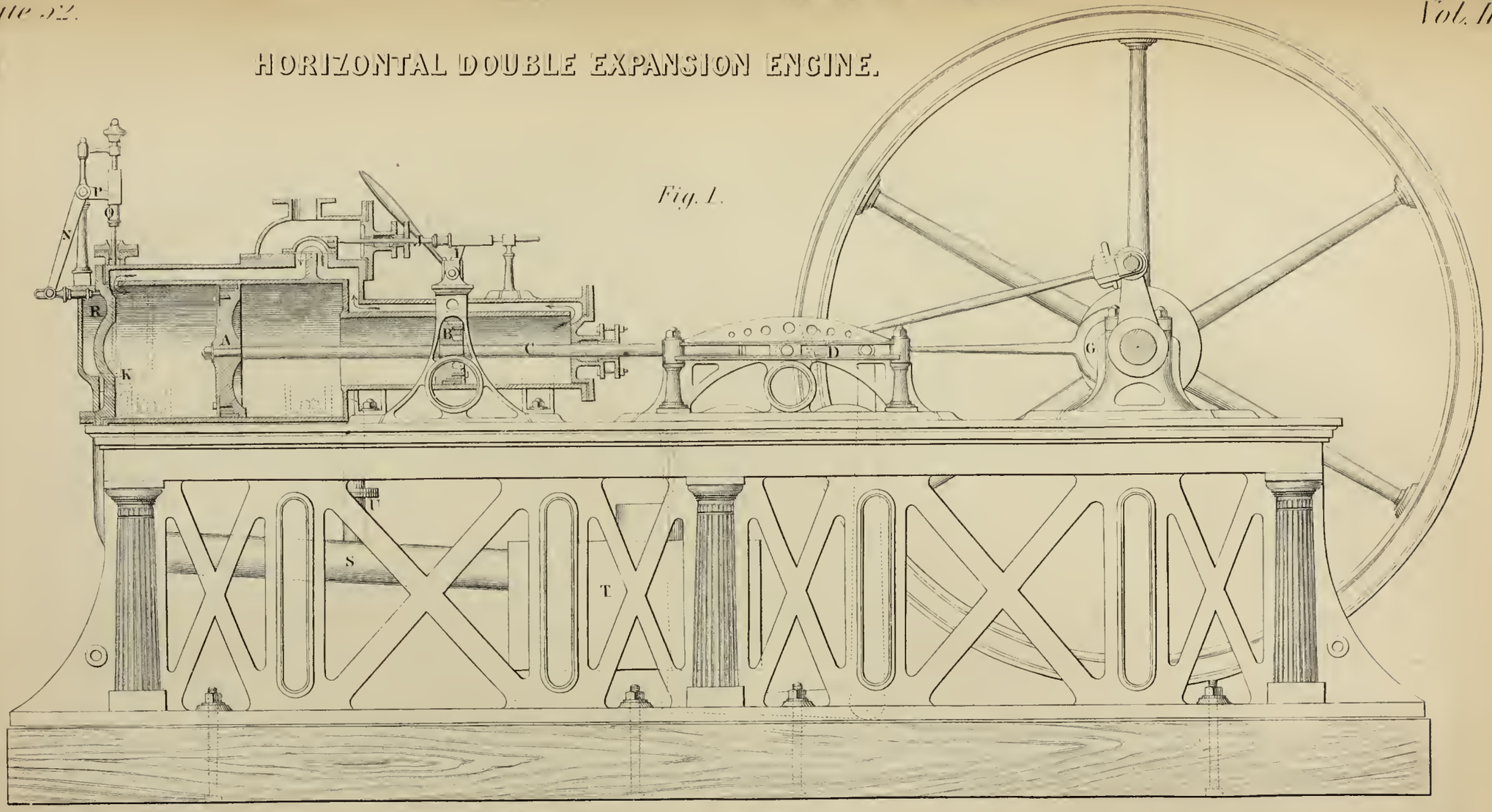
This new consideration is truly of fundamental importance. It is impossible to comprehend the positive method when studied apart from its application, and equally impossible to form a clear and exact idea of it, except by studying, successively and in appropriate order, its application to all the principal classes of natural phenomena. One single science would not be sufficient to this end. For although the method is essentially identical in all, yet each science specially developes certain characteristic processes, the influence of which, being less marked in other sciences, would not be noticed. Thus, for example, in certain branches of philosophy, it is observation, in others it is experiment, and experiment of this or that kind which constitutes the principal means of exploration. In like manner, some particular maxim, forming an integral part of the method, was furnished originally by some particular science; and although it may have been immediately carried into others, yet it is at its source that we must study it, in order to comprehend it; as, for instance, the theory of classification.

In limiting ourselves to the study of a single science, we ought to select the most perfect, in order to obtain a complete notion of the positive method. Now, the most perfect being at the same time the simplest, we should thus obtain only a very incomplete knowledge of the method, because we should not learn what essential modifications it must undergo to be adapted to the more complicated phenomena. Each fundamental science has, therefore, under this view, advantages which are peculiar to it; and this proves the necessity of studying them all, unless we would adopt narrow conceptions and ineffective modes of procedure.

I must here insist—always, however, having reference to the comprehension of my method—upon the necessity, not only of studying philosophically all the different fundamental sciences, but of studying them in the order here established. What rational result can be looked for from a mind which employs itself on the study of the most complicated phenomena, without having previously learned to know what is a *law?* what is *observation?* what is a positive conception? what is a connected piece of reasoning? Yet this is the usual mode of proceeding amongst our young physiologists, who usually, at once, commence the study of living bodies, before they have prepared themselves for it otherwise than by studying one or two dead languages; only having, at most, a very superficial acquaintance with physics and chemistry—an acquaintance almost of no value with reference to a true method, since it has generally not been acquired in a rational manner, nor by setting out from the true starting point. We can easily conceive how important it is to reform so vicious a plan of study. In like manner, with reference to the social sciences, which are still more complicated, would it not be a step towards a truly normal state of society, if we were to recognize the logical necessity of not undertaking the study of these phenomena, until after we had trained our minds by a philosophic examination of all the anterior phenomena? We can even assert that the principal difficulty lies here; for there are few able minds who are not at this

HORIZONTAL DOUBLE EXPANSION ENGINE.

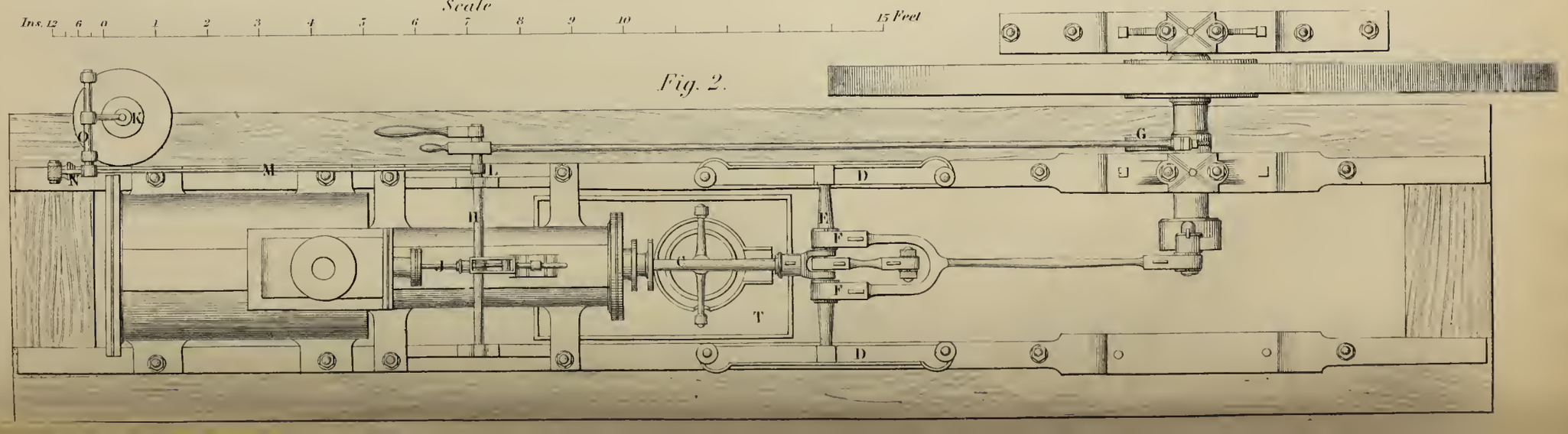
Fig. 1.



Scale

Ins. 12 6 0 1 2 3 4 5 6 7 8 9 10 15 Feet

Fig. 2.



day convinced, that it is necessary to study the social phenomena after the positive method. Only those who devote themselves to this study, not knowing and not being able to see exactly in what this method consists, for want of having examined it in its anterior applications, this maxim has, to the present time, borne no fruit to the reuovation of social theories.

Such, therefore, are the four principal points of view, with respect to which I was bound to show the general importance of the classification I have laid down for the fundamental sciences.

One large and capital omission I have yet to consider—an omission which I designedly made in my encyclopædic formula, and which the reader has doubtless remarked. I allude to mathematical science. The reason of that omission is founded upon the very importance of that science, so vast and fundamental. Its true character, and its position in the encyclopædic scale, will be precisely determined hereafter; but I shall here give a summary of the general results, in order that I may not leave iucomplete the great sketch which I have now before me.

In the actual state of our positive knowledge, it is agreed, I believe, to regard mathematics less as a coustituent part of physical science, than as being, since Descartes and Newton, the basis of the whole; although, to speak with accuracy, it is both the one and the other. At the present day, mathematical science is much less important in respect of the direct information, precious as it is, which it furnishes, than as forming the most potent instrument which the human mind can employ in searching for the laws of natural phenomena. On this account, in order to present a perfectly defined and vigorously exact conception, mathematics must be divided into two parts, essentially distinct: *abstract* and *concrete* mathematics. The latter consisting of geometry in general, on the one hand, and of theoretical mechanics on the other, is necessarily based upon abstract mathematics, and becomes, in its turn, the basis of all physical science, when the phenomena of the universe are considered, as far as possible, geometrical or mechanical. The abstract division is purely instrumental, being nothing more than an immense and admirable extension of logic to a certain order of deductions. Geometry and mechanics, on the contrary, must be regarded as true natural sciences, based, like all others, upon observatiou, although, by reason of the extreme simplicity of their phenomena, they admit of a degree of systematization infinitely more perfect—so much so, in fact, that the experimental character of their first principles has sometimes been misapprehended. But these two sciences have this peculiarity, that, in the present state of the human mind, they are, and always will be, much more employed as a method than in the shape of direct instruction.

Moreover, it is evident that, in thus placing mathematics at the head of positive philosophy, we are only extending that very principle of classification, founded upon the successive dependence of the sciences, as the result of the degree of abstractness of their respective phenomena, which has supplied us with the encyclopædic series already set forth. We are only now restoring to that series its first term. It is plainly to be seen, that geometrical and mechanical phenomena are the most general, simple, abstract, irresolvable, and independent of all, and that they form the basis of all others. The study of them is, therefore, an indispensable preliminary to the study of all other classes of phenomena; and hence mathematical science ought to form the starting point for all scientific education, whether general or special. This explains the custom which, for a long period, has universally obtained in this matter, although it had originally no other reason than the greater antiquity of mathematics, compared with other sciences. We have now, therefore, determined with exactness the plan which ought constantly to guide us in the study of positive philosophy, not by means of vain and arbitrary speculations, but after looking at the matter as the subject of a true philosophical problem. Mathematics, astronomy, physics, chemistry, physiology, and social physics; such is the encyclopædic formula which, amongst the great number of classifications of which the six fundamental sciences are susceptible, is alone logically conformable to the natural and invariable hierarchy of phenomena.

SIMS' HORIZONTAL DOUBLE-EXPANSION ENGINE.

(Illustrated by Plate 52.)

Our plate, 52, presents two views of a very good example of the most improved class of modern Cornish expansive rotatory engines, from the factory of an engineer who has earned for himself a high standing amongst those who have made the Cornish engine what it is—the most economical prime mover in the entire range of steam mechanism.

The effective performance of these engines has long since passed into a proverb, but it was not until Mr. Wicksteed's admirable experiments, ending in the actual carrying off of a complete engine from the East Cornwall Mines to the East London Water Works, that the reported economy of the Cornish arrangement was implicitly believed by practical men. This engine was designed by Mr. W. West, being a counterpart of one erected by the same engineer at the Fowey Consols Mine, which, up to the year 1841, had performed the greatest amount of *duty* ever recorded. After having worked about a year at the Cornish mine, it was removed and re-erected in London by Messrs. Harvey & Co. and Mr. West, it being contracted that it should perform a regular duty, during twelve months, of ninety millions of pounds, raised one foot high, with the consumption of a bushel or 94 lbs. of Welsh coal,—which duty was accomplished.

This result gave an additional impulse to the system, and we have now reason to be as much astonished with the great economy in advance of this performance, as with the latter in comparison with the old system. The plan of reporting the Cornish engines, so effectively managed in Browne's and Messrs. Lean's monthly statements, has a good deal to do with the gradual elevation of the standard of economical working, as well in exciting an honourable emulation amongst the engine attendants to excel, by the utmost care in firing, and in the diligent management and clothing of the boilers and steam-pipes, as in urging the engineers themselves to redouble their efforts in constructive improvement. From "Browne's *Cornish Engine Reporter*," for the beginning of the present year, we find that twenty-nine pumping engines, twenty rotatory-whim engines, and seven stampers, were reported, the highest duty of the pumping engines being that of the *Par Consols*, 80-inch single engine—101·2 millions. It is to be regretted that these reports do not include all the Cornish expansive engines, so as to furnish an unerring exposition of the actual average performance of the district. If this were the case, we are persuaded that many engines would be found to give a far higher duty than that quoted here. This is startling enough to engineers in cheap coal countries, where the consumption of fuel is a matter of secondary importance, and, of course, few or none of the minute attentions to matters of detail, considered so essential in localities where "coals are coals," are ever paid. We have, nevertheless, often thought it most desirable that the reporting system should be adopted in all extensive steam-power districts, as we are persuaded that even here the economy of fuel, and increased efficiency of the engines, would far more than outweigh any slight additional trouble or expense incurred in giving satisfactory reports.

The subject of our plate is the combined horizontal double-expansive engine made by James Sims, Esq., of Redruth, Cornwall. As in the ordinary Woolf's engine, the duplex cylinder has been introduced for the purpose of carrying out the principle of expansion to a much more extended limit than is possible in the single cylinder. This engine is now at work at the Lewes Water Works, in Sussex; it is thirty-five horses' power.

In large engines, two separate cylinders are bolted together, end to end; but in short-stroked engines, the cylinders are cast together, as represented in the section, figure 1. This view shows the complete engine in elevation, with the exception of the cylinders and valves, which are sectioned. Fig. 2 is a corresponding plan. The large and small pistons, A and B, of the corresponding cylinders, are both fast on the same rod, C, the slide blocks of which work in a horizontal grooved guide, D, supported on two end pedestals bolted to the entablature of the framing. The cross-head, E, connects the piston rod to the connecting rod, which has a large forked end, with straps and brasses, F F. The side frames are composed of sets of three fluted columns, with diagonal framing and panels between, carried on a bottom frame of timber. The entablature surmounting the standard frames carries the whole of the machinery, cylinders, guide-frames, and crank-shaft. The large cylinder is bolted down to the entablature by four side brackets, cast on the former, and a similar set, of greater length, carry the smaller cylinder.

The valve gear is of the simplest description. The eccentric, G, on the crank-shaft, is connected by its rod, direct to the lever of the rocking-shaft, H, the upper lever, I, of which is linked to the spindle of the slide valve, J, on the upper side of the large cylinder. In action, the steam is first admitted to the front side of the small piston, and, except in very short-stroked engines, it is cut off from this cylinder by the lap of the valve as usual, the remainder of the stroke being accomplished by simple expansion. At the termination of the stroke, the comparatively high pressure steam, on the front side of the small piston, is allowed to discharge itself into the large cylinder, at the back of the piston, for the reverse stroke. The ratio of the areas of the two pistons is as four to one, so that, when steam is discharging from the small cylinder into the large one, and the pressure on each being thus equal on equal areas, the large piston has an available area of three times that of the small one, and this opposite pressure produces the return stroke. When the pistons each regain the front ends of their cylinders, the expanded steam is exhausted from the end of the large cylinder by the lift-valve, K, which

is worked from the slide-valve eccentric, by the intermediate lever, L, on the rocking-shaft. This lever is connected by the rod, M, with the lever, N, on the short rocking-shaft, O, which carries a second lever, P, linked to the vertical valve spindle, Q. The steam exhausts by the nozzle, R, into the pipe, S, leading to the condenser, T; and from this pipe, S, a small branch, U, opens a communication with both cylinders between the two pistons, so as to preserve a constant vacuum between the two.

It will thus be seen that fresh steam is admitted to the small cylinder at each alternate single stroke only, at which time the movement is obtained by the pressure made up of the direct steam action on the small piston—partially expanded, according to circumstances—in conjunction with the vacuum between the two pistons, the advantage of which—as there is also, at this period, a vacuum on the opposite side of the large piston—is gained by the smaller one. The reverse action arises from the difference in the areas of the two pistons, when a communication is opened by the slide-valve between the opposite sides of each, added to the central vacuum, which now gives its assistance to the large piston.

The fact of the actual exhaust only taking place once in every double stroke, is, of itself, a feature of considerable importance in the economy of the engine, as, in the usual arrangements, a considerable quantity of steam is discharged as useless at each single stroke.

The section of the cylinders and valves shows the peculiar arrangement of the latter. In the position chosen for illustration, the steam is supposed to be discharging from the front of the small piston to the back of the large one, as indicated by the arrows. There are only two ports, which are formed in the upper side of the large cylinder, and the passages from these open into reverse ends of the two cylinders. With this arrangement, when the slide-valve is pushed towards the outer end of the large cylinder, the front port becomes uncovered, to admit steam from the boiler to the small cylinder; and, in the reverse position, this port is covered, and the two passages are put in communication with each other as delineated, by the hollow of the valve covering both ports.

The regularity of movement obtained by this system of expansion is very beautiful, and allows of the adoption of the utmost economical expansion, in works where the irregularity of the single cylinder expansion would be a fatal bar to its use. In a cotton-spinning factory, for example, where the delicacy of many of the operations renders a perfectly equable movement imperatively necessary, the advantages of Mr. Sims' engine, in this respect, are eminently conspicuous; and this has led to its introduction for a great variety of manufacturing purposes, as for flour-mills and silk factories, in addition to the many duties connected with mining, as pumping, stamping, and winding. It is when placed in competition with the Boulton and Watt double-acting crank engine, working non-expansively, with a stroke of 4 feet, and below that the new engine shows itself to the greatest perfection—the saving of fuel being generally about 40 per cent.

The proportions of the two cylinders are so arranged as to admit of both strokes being made with exactly equal power; and the engine does in effect perform the same amount of work as the single cylinder double-acting engine, having a cylinder the same size as the small one in the new arrangement—minus the additional friction of the second piston, calculated at one-fifth.

For marine purposes, where coal stowage has at any rate to be considered, whatever may be the actual cheapness of the fuel, we should suppose this engine would be particularly valuable; and as it is cheap and simple in construction, we do not see why manufacturers ought not to take advantage of its economy, even in stationary engines in cheap fuel districts—for a penny saved is a penny gained. We believe the horizontal engine is rapidly superseding Mr. Sims' former vertical arrangement. One is now being erected at the Duke of Buccleuch's colliery at Canonbie, near Carlisle. In speaking of the behaviour of his engine, Mr. Davey, of the Lewes Water Works, says—"The patent engine continues to work daily very satisfactorily; the quantity of coals consumed, screenings, is under 6 cwt. per day, being slightly more than one-half the quantity consumed by the former engine performing the same work."

TERRESTRIAL MAGNETISM.*

Aurora Borealis.—The aurora borealis, or polar lights, show by their influence upon the needle, that they are connected with terrestrial magnetism. Humboldt regards them not as a cause of the perturbation of the needle, but as the result of a state of telluric activity, excited to the production of a luminous phenomenon. The light indicates the termination of a magnetic storm, the act of discharge by which equilibrium in the distribution of the magnetism of the earth or its atmosphere is restored. The northern lights have been seen as far south as the 45° of S. latitude, and the southern lights have been repeatedly seen in England. As to the height of the auroral phenomenon, the measurements vary from a few thousand feet to several miles. Streamers have sometimes been seen below the clouds, whilst transverse luminous arcs have been calculated to attain the height of 110 miles. Some observers assert, that a crackling or hissing noise was heard on the appearance of the aurora, but others, who, together, have witnessed thousands of northern lights, never heard the slightest noise. We now transcribe Humboldt's graphic description of the commencement and successive phases of the complete appearance of the aurora. Low down on the horizon, about the part where it is intersected by the magnetic meridian, the sky, which was previously clear, is darkened by an appearance resembling a dense bank or haze, which gradually rises and attains a height of 8° or 10°. The colour of the dark segment passes into brown or violet, and stars are visible through it as in a part of the sky obscured by thick smoke. A broad luminous arch, first white, then yellow, bounds the dark segment; but as the bright arch does not appear until after the segment, Argelander considers that the latter cannot be attributed to the mere effect of contrast with its bright margin. The azimuth of the highest point of the luminous arch, when carefully measured, has been usually found not quite in the magnetic meridian, but from five to eighteen degrees from it, on the side towards which the magnetic declination of the place is directed. In high northern latitudes in the near vicinity of the magnetic pole, the dark segment appears less dark, and sometimes is not seen at all; and in the same localities where the horizontal magnetic force is weakest, the middle of the luminous arch deviates most widely from the magnetic meridian. The luminous arch undergoes frequent fluctuations of form; it remains sometimes for hours before rays and streamers are seen to shoot from it and rise to the zenith. The more intense the discharges of the aurora, the more vivid is the play of colours, from violet and bluish-white, through all gradations, to green and crimson. In the common electricity excited by friction, it is also found that the spark becomes coloured only when a violent explosion follows high tension. At one moment the magnetic streamers rise singly, and are even interspersed with dark rays, resembling dense smoke; at another, they shoot upwards simultaneously from many and opposite points of the horizon, and unite in a quivering sea of flame, the splendour of which no description can reach, for every instant its bright waves assume new forms. The intensity of this light is sometimes so great, that its corruscations have been discerned during bright sunshine: motion increases the visibility of the phenomenon. The rays finally cluster round the point in the sky corresponding to the direction of the dipping needle, and there form what is called the corona—a canopy of light of milder radiance, streaming, but no longer undulating. It is only in rare cases that the phenomenon proceeds so far as the complete formation of the corona; but whenever this takes place, the display is terminated. The streamers now become fewer, shorter, and less intensely coloured; the corona and the luminous arches break up, and soon nothing is seen, but irregularly scattered, broad, pale, shining patches of an ashy-grey colour; and even these vanish before the trace of the original dark segment has disappeared from the horizon. The last trace that remains of the whole spectacle is often merely a white delicate cloud feathered at the edges, or broken up into small masses like cirro-cumuli.

Instruments.—The magnetic instruments used by observers consist of a declination instrument, a horizontal force magnetometer, a vertical force magnetometer, and a dipping needle. The first is a magnetized bar of steel, from 12 to 15 inches in length, 1 inch broad, and ¼ inch thick, suspended in a horizontal position by means of silk fibres. It is enclosed in a box to protect it from wind. Light is thrown into the box through an aperture, in order that its indications may be observed, and the movements of the bar are ascertained from a distance by means of a telescope commanding another aperture. The horizontal intensity is determined by the bifilar magnetometer, a bar suspended like the former by a stirrup of silk fibres. The principle consists in ascertaining the amount of torsion suffered by the suspending fibres in retaining the bar at right angles to the magnetic meridian, in opposition to its tendency to occupy a position parallel with that meridian. The vertical force magnetometer is also a magnetized bar, in the middle of which, on its under side and at right angles to its length, is a short axle cut away to a fine edge. The bar is balanced by means of this edge upon a plate of polished agate. On each arm there is a screw; one of which, acting at right angles to the magnetic axis of the bar, causes the centre of gravity to coincide with the knife edge. The other screw is parallel to the magnetic axis, and by means of it the bar can be made to assume a horizontal position. When thus adjusted and counterpoised, all its movements are directly referable to changes in the amount of the vertical magnetic force which opposes the action of the screws. By this instrument, a change to the extent of 140,000th part of the total magnetic intensity may be detected.

* Concluded from page 61.

It is by observing the number of oscillations made by a needle forcibly removed from its position before assuming a state of rest, that the intensity of magnetic force is measured.

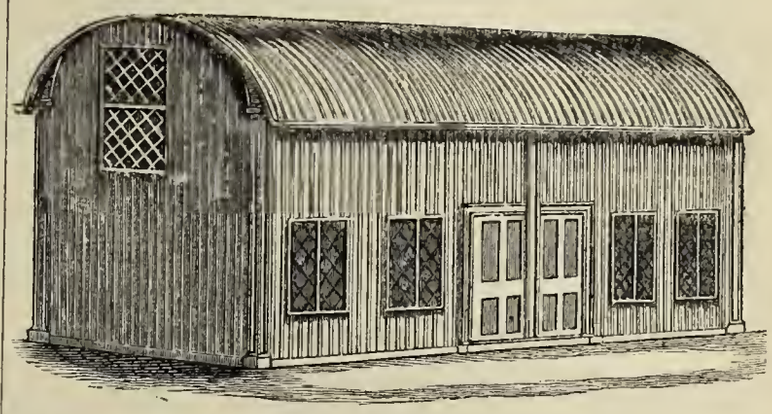
System of Observation.—In order to the complete detection and deciphering of the phenomena, it was evident that a uniform scheme of observation should be carried on at all the established observatories, and that the observations should be exactly simultaneous. "Each day is, in the first place, supposed to be divided into twelve equal portions of two hours each, commencing at all the stations at the same instant of absolute time, which may be called the magnetic hours, viz. 0 h. 0 m. 0 s., 2 h. 0 m. 0 s., 3 h., &c., of mean time at Göttingen, without any regard to the apparent times of day at the stations themselves, which will, of course, differ by their differences of longitude, so that the first magnetic hour which, at Göttingen, commences at noon, will, at Dublin, for instance, (1 h. 5 m. 8 s. west of Göttingen,) commence at 10 h. 54 m. 52 s. a.m.; at Madras, (4 h. 41 m. 42 s. east of it,) at 4 h. 41 m. 42 s. p.m. At the commencement of every magnetic hour throughout the day and night of every day, (Sundays excepted,) the magnetometers are observed. To multiply opportunities for observing remarkable coincidences, the observation at 2 p.m. Göttingen mean time is, in all cases, a triple one, the magnetic readings being thrice repeated in a given order at intervals of five minutes. The Göttingen terms, commencing on the Friday preceding the last Saturday in February, May, August, and November, at 10 p.m. (Göttingen M.T.), and continued at intervals of two minutes and a half, according to a settled order of the instruments, through the subsequent twenty-four hours, are observed at all the stations; and moreover, eight additional terms are introduced, viz. on the Wednesday preceding the 21st of each remaining month, commencing at the same hour, and extending to the same series as the other terms."

History.—A thousand years before the Christian era, the Chinese employed a magnetic apparatus to guide them in their travels across the vast plains of Tartary, and in the third century of our era (700 years before the compass was used on the seas of Europe), Chinese vessels were steered in the Indian Ocean by needles which pointed to the south. When Halley returned home from his second voyage, he published, in 1701, a chart of isogonal lines, so far as observation then enabled him—and this work, coupled with his own discoveries, entitle him to be regarded as the father and founder of this branch of science. Forty years, however, by reason of secular changes, were sufficient to render it obsolete as far as it had been of use to navigators, and a new chart was constructed about 1750, by Mountain and Dodson, who undertook the task of executing maps for five epochs, separated by intervals of eleven years, one of which was predicted. It was not until Rossels' expedition in search of La Perouse, 1791–94, that the fact of differences of the magnetic intensity at different places was discovered. The subject of terrestrial magnetism occupied much of Humboldt's attention in his travels through equinoctial America, and on his return to Europe, he examined, with great care, the movements of the needle, both night and day, in 1806–7. It was he who first noticed those irregular perturbations to which he gave the name of magnetic storms, and which were found in 1818, by the observations of Arago at Paris, and Kupffer at Kasan, to be synchronous at different places. In 1819, Hanstein of Christiania published a valuable work on terrestrial magnetism, for which materials had been collecting during several years. Various persons then contributed their personal observations to the science, including Hanstein, Due, Erman, and Sabine; and Humboldt used his great influence in urging his own and other governments to build and endow observatories, solely to watch and report upon magnetic phenomena. In the course of time, no fewer than eight observatories were established in the Russian empire, one at Pekin at the expense of Russia, fourteen in Germany, one in Denmark, and in addition to those at Greenwich and Dublin, the British government has established observatories at Toronto (Canada), St. Helena, Cape of Good Hope, Van Dieman's Land, Madras, Simla, Singapore, and Aden. In 1839, Sir James Ross was sent into the Antarctic Ocean with two vessels, fitted up with every requisite for taking accurate observations, and he returned in 1843, bringing important additions to the stock of magnetic facts. Amongst the most eminent living philosophers, whose theoretical investigations and practical inventions have largely contributed to the furtherance of the science, may be mentioned Gauss of Göttingen, and Professor Lloyd of Dublin. The Royal Society, the British Association for the advancement of Science, and the German Magnetic Association, have been honourably distinguished by their zeal, in encouraging the prosecution of researches in terrestrial magnetism. Mr. Fox's name ought to be mentioned in connection with the apparatus invented by him for determining, on board sailing vessels, the amount of total magnetic intensity, which it effects with extraordinary accuracy.

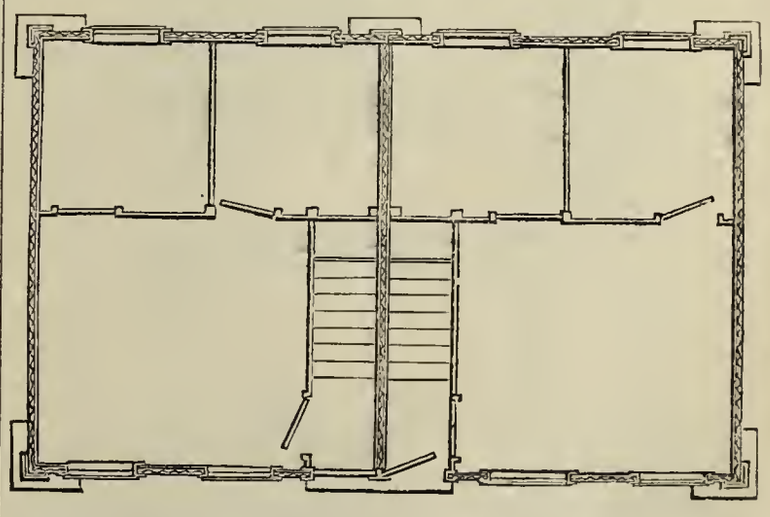
IRON-HOUSE BUILDING IN GLASGOW.

Until very recently, the applications of iron for the builder's purposes were confined to a few simple details, where the use of so manageable a material was distinctly obvious. Now, however, a more extended field has been opened up for it, by that spirit of scientific application which prompts the seeking out of new materials, and the adaptation of old ones to new uses. We have just seen a good example, which comes under the latter class, in the shape of two iron houses, made by Messrs. Chaplin, Dixon, & Robb, of Cheapside Street, Anderston. In these erections, iron has utterly usurped the place of stone—the walls, roof, window-frames, and even the door-steps and lintels, being all of metal.

Our engravings represent a perspective elevation and sectional ground plan of the two houses, which are contained in one framework, divided



by a central iron partition. The length of this double house is 32 feet, by 20 feet in breadth. The doors adjoin each other at the centre, and open into lobbies, from which, doors right and left open into the large front living-room of each domicile. This room is lighted by two lattice windows in the front, and forms a good roomy apartment. At the back are two doors, opening into two smaller rooms, each with a window in the back wall. These serve for very respectable bedrooms, and, when we saw them, were fitted with iron bedsteads and the usual accompaniments, as an illustration of their finished appearance. From the inner end of the entrance lobby, a stair leads up to an upper apartment, of the area of the whole basement. This may, of course, be used either as a



store, or for division into smaller rooms for family accommodation. The walls, roof, and partitions are of corrugated iron, of No. 20 guage, the corrugations being 5 inches broad, by 1¼ deep—the whole frame being supported by six neat cast-iron pilasters. The bottom flooring is made in the usual manner, but the upper floor is a novelty, being made of 3-inch planks, grooved and feathered with iron, rendering all joists unnecessary, and presenting a smooth flat floor to the upper room, with an equally clear ceiling to the lower one. The ends of the flooring-planks are carried on angle-irons running round the interior of the walls, and these, at the same time, bind together the framework.

The roof is convex, the height of the house being 12 feet at the eaves, and 16 feet at the centre. Although unfavourable to the general appearance of the house, this arched roof adds immensely to the strength; and the emigrant cares little for architectural beauty, if he can secure strength and lightness.

The whole of the rooms are lined with substantial planking, planed and headed, and put together, as is the whole of the rest of the building, without a single nail or pin. The weight of the two buildings is about nine tons, and the total cost about £200. The work is highly creditable to the makers, who are to be distinguished as the introducers of this department of construction into this neighbourhood.

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Science, Guide to, 5th edit., 18mo, 3s. 6d. cloth. Rev. Dr. Brewer.
Screw Fleet of the Navy, The, royal 8vo, 5s. cloth. E. P. Halsted.
Sketching from Nature, Treatise on, royal 8vo, 6s. 6d. cloth. J. Wood.
Steam-Engine, On the Expansive, 4to, 16s. half-bound. P. R. Hodge.
Surveying, Rudimentary, 12mo, 2s. cloth, (Weale.) T. Baker.

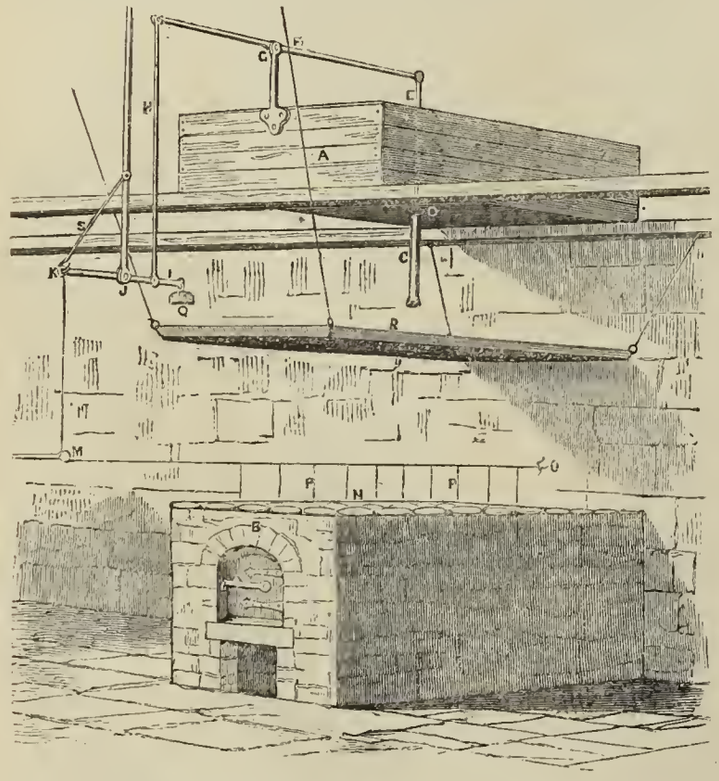
REGISTERED DESIGNS.

SELF-ACTING FIRE EXTINGUISHER.

Registered for M. O. Bergin, Esq., *Cork.*

Mr. Bergin's ingenious invention has, for its object, the prevention of serious consequences from accidental fires in certain operations or situations, where flame is not exhibited in the ordinary action of the apparatus—as in ovens, stoves, kilns, boilers, and drying chambers—as well as in arrangements of machinery liable to ignition from friction, and materials which are prone to spontaneous combustion.

Our engraving represents a perspective elevation of the apparatus, as



fitted to a biscuit oven and kiln, where there is danger to be apprehended from fire during the absence of the workmen. A water cistern is fixed up at A, above the oven, B, having a vertical discharge pipe, C, passing out of its bottom. This pipe opens into the cistern, a valve opening upwards being placed at D, to regulate the flow of water. A rod, E, passes up from this valve to a double lever, F, turning on a centre at G. From the opposite end of this lever, a rod, H, passes downwards to a second lever, I, turning on a centre at J. The opposite end, K, of this lever has attached to it one end of a fuse cord, L, which is passed round a guide pulley, M, and is afterwards led horizontally across the surface of the kiln, N, on the top of the oven, being fastened to the wall at O. The fuse cord, L, carries a series of short tails or strings, P P, hanging down to within an inch of the surface of the kiln, and being composed of an easily inflammable material, should the biscuits on the kiln ignite, it will be at once burnt through, thus releasing the weight, Q, on the end, I, of the lower lever. The fall of this weight then opens the valve, D, permitting water to flow down the pipe, C, on to the perforated sheet-iron tray, R, suspended by metal links at its four corners over the oven. This tray spreads the water out into minute jets, by which the burning biscuits beneath are extinguished. To release the fuse cord from the strain during the attendance of the workmen, a link, S, is made adjustable, at one end, to the end of the lever, K, and, at the other, to the fixed suspension rod of the lever. This is removed when the apparatus is left unattended.

It is obvious that this inexpensive contrivance may be fitted up in various localities; indeed, the principle of the attachment of the supporting fuse cord of the water-valve may be applied wherever the risk of accidental fire may call for it. Its simplicity must at once secure for it an extensive trial, and we doubt not but that, when duly tested, it will be found largely available by insurance companies, in giving them the means of taking what are now hazardous risks at a moderate premium.

The great value of the apparatus consists in the fact that it is self-acting, and comes into operation at the moment when most wanted—that is, when the fire is in its early smouldering state, and when the application of a gallon of water serves a better purpose than all the fire-engines that can be brought to bear at a later period.

It must never be forgotten that all sufferers by fire, whether insured or not, are losers in one very important point—time. No remuneration for actual loss, payable by an insurance company, can compensate the owner of extensive buildings for the loss of the use of the premises during re-erection. This is of far greater importance than the proprietors of buildings are willing to believe, until a fire finds it out for them. If Mr. Bergin's invention were alone serviceable for the removal of this one evil, it would deserve a trial.

REVIEWS OF NEW BOOKS.

The St. Helen's Crown Glass Company's Trade Book of Patterns of Ornamental Window Glass.

Business circulars do not frequently find their way into the pages of a review; but, although a "trade book," the present production is something more. It is a sample of the "art-manufactures" of 1850—a statement of what is doing by those who give form to the creations of the artist—a model drawing-book for the young student—and a magazine of hints for the artist's patron.

The book is divided into two parts, the first of which engrosses forty-two sheets of patterns, containing no fewer than 231 distinct devices, which embrace every variety of ornament. The most of these are rendered in a green or brown tint; but, here and there, the finished effect of the mere outline is expressed with all the force of brilliant colours.

The second portion is devoted to a set of eight sheets of "designs for church, hall, staircase, and memorial windows," by Mr. Frank Howard. The drawing on the stone and the colouring of these sheets have had the benefit of Mr. Howard's personal superintendence, and are all that could be desired in the way of clever drawing and judicious tinting. The designs comprehend—1. *The Transfiguration.* 2. A single-light window with symbolic devices; a corresponding one of the *Virgin and Child;* and a two-light of *St. Paul and St. Peter.* 3. *The Adoration of the Shepherds:* the lower divisions filled up with the *Evangelists and St. John the Baptist.* 4. *The Fathers of the Church.* 5. *Medallion window.* 6. *Memorial windows.* 7. *Library window.* 8. *Turret Light, Staircase and Sporting Lodge windows.* The general effect of the first of these is very beautiful, and the same may be said of the "memorial windows," No. 6. No. 7, "library window," at once reminds us of the large window at Hampton Court.

The earlier portion of the book gives some useful "explanations of terms" used in this beautiful art, and a catalogue of the various "methods of execution." The library department, as well as the general arrangement of this large* and handsome volume, bear evidence of the careful editorial management of Mr. Henry Deacon, the manager of the company's works, and an old correspondent of our own. Whilst we congratulate him on the taste which he has here displayed, a word is due to the "St. Helen's Crown Glass Company" for the liberality which has seconded his endeavours.

* Its size is 13 inches by 10.

UNIVERSITY OF ILLINOIS LIBRARY

A Catechism of the Steam-Engine. By John Bourne, C.E. Third Edition. London: Longmans, 1850.

When a book has attained its third edition, the reviewer can have little to say to it. It has achieved its independence, and carries on its title-page the best of all credentials. Mr. Bourne's little book has deservedly gained this proud position, and whether regarded as a literary effort, or as a sound epitome of modern engineering practice, it is equally entitled to our recommendations.

CORRESPONDENCE.

ARTIFICIAL LIGHT.—IMPROVEMENTS IN COMBUSTION.

Next to food and clothing, artificial light ranks among the common wants, if not necessities, of man, imparting, during the dark hours of night, a cheerful gleam, enabling him to pursue some useful avocation or recreation, at a time when otherwise he must be in idleness or slumber. We are abundantly supplied, naturally, from the animal, vegetable, and mineral kingdoms, with materials for producing illumination in our streets and apartments, and it only remains for man's ingenuity to contrive means by which these ingredients may be obtained, and made to yield to him the *whole* of their useful properties. Numerous as were the means of *producing* artificial light, from the rubbing together of pieces of wood by the rude and uncivilized nations, to the present simple modes, the construction of torches, flambeaux, lanterns, cressets, and lamps, and the manufacture of gases, has called forth the ingenuity of nations for ages, for the purpose of causing the light thus obtained to continue an uninterrupted flame at the pleasure of the consumer, at the least possible cost; for the illumination of the atmosphere in the dark depends, not upon the quantity of fuel consumed, but upon the manner of consumption, that the greatest quantity of solid matter, such as carbon, may be fixed in the flame, and heated to intensity; and this will be attended by the evolution of light in proportion to the brilliancy and external surface of the flame produced, the former causing the light to penetrate the atmosphere to some distance, while the latter gives power of illumination.

Combustion, or burning, is a process—the union of hydrogen and oxygen, with the presence of carbon*—by which both light and heat are emitted by chemical agency—that is, matter is acted upon, it undergoes a change, or is decomposed, and matter in other forms presents itself. Thus, by examining the flame of a candle or lamp, or that produced by the burning of a piece of dry wood, paper, or any other inflammable substance, it will be found to consist of three distinct parts. That portion of the flame of a lamp or candle which surrounds the wick, and tapers to a cone just above it, appearing more or less blue and transparent, contains the hydrogen of the fat, burning with the oxygen of the fat and that of the atmosphere, and gives intense heat, without the evolution of light. The brightest part of the flame surrounding the upper part of this transparent cone contains the carbon of the fat more or less heated by its union with the oxygen and hydrogen. Some of this carbon unites with the carbon contained in the cotton wick, and produces the thick snuff, which—in the case of a lamp—after several hours burning, becomes carbon in a solid and exceedingly hard mass, and eventually destroys the capillary attraction, causing the best lamps visibly to diminish their light. The top portion of the flame, which in imperfect combustion is generally of a dull red or brown colour, is composed of the *products* of combustion, viz., aqueous vapour, and decomposed carbon—carbonic acid—and, in the case of imperfect combustion, the carbon which has passed through the flame when there has not been sufficient heat to fix it in the flame. These products mingle with the atmosphere, after combining, the former with eight times, and the latter—carbonic acid—with three-eighths, of oxygen by weight. The watery vapour condenses upon the first cold surface with which it comes in contact, but the carbonic acid accumulates in proportion to the extent of combustion compared with the ventilation of the apartment. In the case of a lamp, the cotton wick causes the oil to rise by capillary attraction, and presents itself on a large surface to the action of the atmosphere. This being ignited, imperfect combustion commences—that is, the oil is undergoing decomposition, and producing light and heat; but the vapourised oil not being all consumed, the carbon may be seen flying off in smoke, which is not only offensive, and destructive to pictures, ornaments, &c., in the apartment, but attended by a great loss of fuel in proportion to the light obtained; for that very smoke, if consumed in a proper manner, would give brilliancy to the flame, without any extra consumption of fuel. In order, then, to *fix* this carbon in the flame, a greater intensity of heat is required; and to produce which, a greater quantity of oxygen is necessary than is drawn into the flame through the rarefaction of the atmosphere by the heat of the burning material. Oils and fats contain carbon, hydrogen, and oxygen, in certain proportions; and these, by being ignited, undergo certain changes, under different circumstances. The carbon is heated to incandescence by its union with hydrogen and oxygen, the hydrogen is thereby vapourised, and, being the lightest known substance, "flies off," and the oxygen supports combustion while there is any combustible material in a state of ignition for it to act upon.

These properties of matter have given rise to the invention of many beautiful contrivances for burning oil and tallow, all of which consist—first, in the arrangement of the wick for the greater facility of burning the oil or tallow; secondly, in keeping that wick constantly supplied with the unctuous matter; and, thirdly, in admitting a free current of atmosphere to act upon the flame in such quantities, and at such parts,† as to cause the oxygen contained therein to come in contact with the fixed carbon, and to penetrate the inner part of the flame.

In consideration of these facts, I conceived that a light might be produced at one-third the cost from a flat wick, equal in brilliancy and power of illumination to one emanating from a circular wick of three times the length, taking the diameter of the circle instead of the circumference; the advantages derivable from such a plan being a certain steady light, of a pure white colour, quite free from smoke or smell, of sufficient power to illuminate, through a ground glass shade or otherwise, a tolerably large room, from the combustion of the commonest inflammable oils; and while the opulent might avail themselves of these advantages, the apparatus for effecting them is so void of complicated machinery, that the working man may have the same light at a much less cost per hour than he is paying for his halfpenny candle, and without attention. Thus, by a simple application of science, one of the common wants of man is brought within the reach of all classes; and as I was enabled to bring my theory into successful practice, I was induced to give the public the benefit of my invention, if such it may be termed; the advantages contemplated being, a cheap light available to all classes, attended by no danger either to person or property; that it should be a *healthy* light—that is, that the atmosphere in a small room should not be vitiated to any great extent by its amount of combustion; and that it should give as little trouble as possible in comparison to its usefulness.

Annexed are sketches of the burner of my "Oxydate Condensing

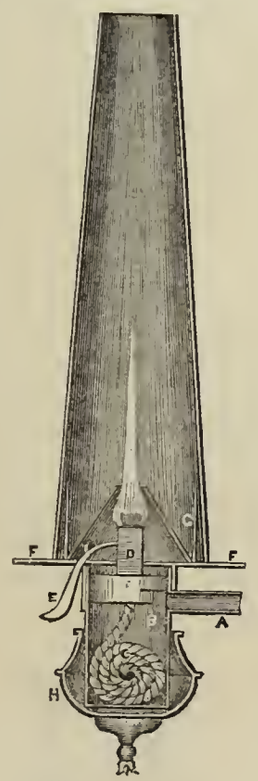


Fig. 1.

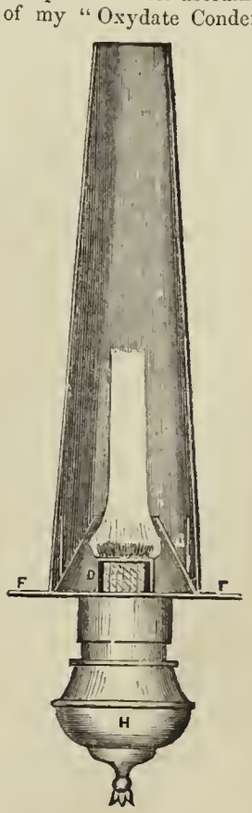


Fig. 2.

Lamp," which is so constructed as that it may be attached to any oil lamp now in use, in addition to the many new forms which I have adopted.

* Pure oxygen and pure hydrogen, in combining, give out great heat, but little or no flame, so that the presence of carbon is necessary to the production of *light*.

† It has been argued, that "the atmosphere is mostly needed at the lower part of the flame." In this case it is gradually absorbed, without producing any great brilliancy in the light, and has a tendency rather to scatter or disperse the carbon. But in coming in contact with carbon partially fixed, it has a tendency to fix more, and thereby increase the brilliancy of the light. This is a subject for discussion.

The sizes of these burners vary from the smallest hand or bed-room lamps, to those of very large dimensions; but the ordinary size is one inch in diameter. It works freely upon a small upright pin, passing through its central oblong aperture; and, when not in use, drops from the wick case, but still hangs by the upright at a sufficient distance from the flame to prevent heating.

Fig. 1 of the sketches is a side view in section. A, Is a pipe leading from any kind of oil reservoir, and communicating with a barrel or pipe, B, into which the oil runs, and finds its level at the top of the opening of the pipe. Into this barrel a small coil of flat cotton wick, C, is placed, after being passed through the wick-carrier, D, which is slid into the barrel, and kept in its place by locking in a small pin in the front. At E is a small lever or probe, which works upon a pin, and raises or depresses the wick, instead of using a rack and pinion, or screw. F, Is a glass-holder and "condensing cap"—the former is made to take a glass chimney, which is kept in its place by the slight pressure of four thin spring wires, G G, &c., and a small globe, or other ornamental shade glass. This glassholder, cap, &c., is in one piece, and fits upon the outside of the barrel, from which it may be "slipped off," for the purpose of lighting the wick. The condensing cap, through which the flame passes, is so constructed, as that a large stream of the atmosphere is admitted at the bottom, which, in its ascent, is condensed, being forced to pass through a small elliptical opening at the top; and from the peculiar shape of this cap, the stream of ascending air meets the flame more directly in the middle, where the greatest quantity of oxygen is required. At the lower part of the cap, the air is admitted (in the ordinary-sized burners) within a circle of $1\frac{3}{4}$ inches diameter, and is condensed to an ellipse of one inch by $\frac{3}{8}$ inch. Between the outer circumference of the bottom of the cap, and the inner circumference of the glass chimney, a small but even current of air is admitted, part of which is deflected into the flame outside the cap, while the remainder rushes rapidly up the chimney, and drives away the products of combustion. An external elevation of fig. 1, with the "condensing cap" only in section, is given in fig. 2. The oil cap at H is not absolutely necessary. It slips on and off in the same manner as the glassholder, and serves, in the side lamps, as a depôt for snuffs, as well as for an ornament.

The flame thus produced is of a pure and delicate white, averaging, in the ordinary-sized burners, two inches in height, reducible to a mere speck, or capable of being raised three inches without smoke. The breadth and thickness of the flame are correctly given in the sketches.

To enable parties to obtain a light of more power than the lamp is regulated or adjusted to, the glass-holder is made to slide up and down at pleasure. It is, however, seldom necessary to interfere with the regular action of the lamp, as the light evolved from one of the common-sized burners, with a wick of one inch diameter, and less than half an inch up, will throw a distinct shadow upon a light-coloured surface through the light of twelve No. 8 tallow candles, the lamp being 16 feet from them, and the opaque body midway.

J. S. Nibbs.

Easlow, Chesterfield, July, 1850.

PIPE-TILE CUTTING APPARATUS.

In your number for May, there is, at page 38, a drawing and description of a registered design for a drain-tile cutting apparatus, the object of which is to make the ends of the pipe-tiles curved instead of straight, so that, when laid, they may not so easily move out of place, and the straight line of the drain be more accurately maintained. I beg to acquaint you, that pipe-tiles have been made in large quantities at these works with this view, for two seasons back, and disposed of all over the west coast here. They are called *checked-end* pipes; and being cut in a much simpler way than that shown in your engraving, I think it worth calling your attention to them, particularly as the other mode has been registered.

At these works, the check is produced by the form of the *cutting-wire;* and the wire is maintained in this form by being attached to two vertical needles, forming a kind of zig-zag, as in fig. 1, and which passes vertically through the continuous tube of tile, and cuts to the same form in the lengths required, and just as easily and accurately as it did when the wire was straight. A line is also scratched along the outside of the tile as a guide in laying; and the check may either be made to lie vertically or horizontally in the drain. When laid in continuous line, they appear as in fig. 2, and when properly filled in make the drain secure. Theoretically, the check protects against movement in one direction only; but practically, when laid and properly filled in, it does so both ways.

Fig. 1.

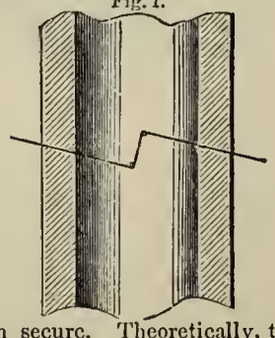
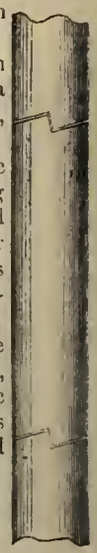


Fig. 2.



To obviate the theoretical defect, and make the junction firm both ways, I had a design last season for giving the ends a curved instead of a straight cut vertically, so that, when laid, they would neither move out of the line one way or other.

This I meant to effect, simply by making the guides of the cutter curved instead of straight, so that the wire, in passing down, would have cut a curved instead of a straight line; and this would have prevented the ends from passing each other in one direction, just as the check does in the other. This seems similar to the mode proposed by Messrs. Dean & Thorburn, but much simpler.

The essential difference between the two designs is, that the check is effected here by the form of the cutting-wire, whilst, in the apparatus which you have published, it is given by the movement. In the second improvement here, the curve was proposed to be added to the check, and that was to be effected by the curving of the guides which were previously straight.

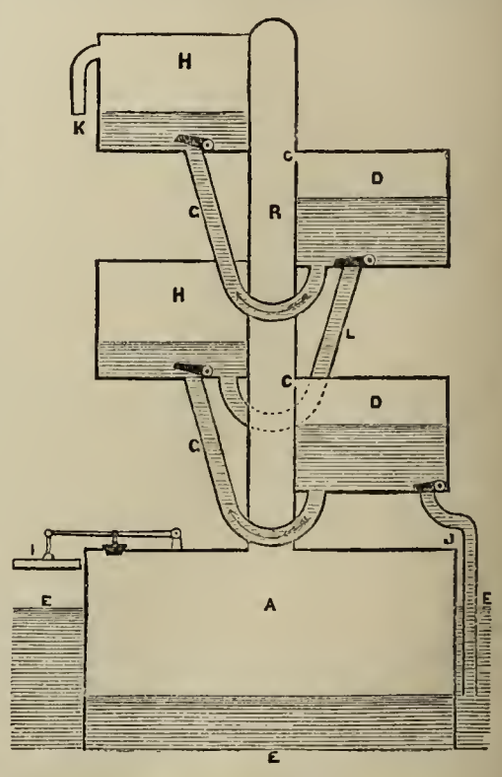
John Todd.

Newfield Tile Works, Kilmarnock, June, 1850.

TIDAL WATER ELEVATOR.

The accompanying sketch represents a sectional elevation of a machine which I had made in London, about a year ago, for the purpose of testing an idea of my own for raising water. As the arrangement worked very well, it has occurred to me that it might be useful in practice in certain situations, where water is wanted at a level above the source of supply.

A, Is a large sheet-iron cylinder case, open at the bottom, but closed at the top, from which the vertical pipe, B, also closed at the top, projects upwards to the required height; and at the parts, C C, this pipe opens into the closed chambers, D D. The base line, E, is low-water level, and the cylinder, A, being supposed to be full of air when the tide rises, the contained air becomes compressed in the interior, as shown in the figure, the real tide-level being at F F. This air pressure then acts on the surface of water in the vessels, D D, forcing it through the pipes, G G, as indicated by the arrows, into the open topped receivers, H H. At high tide the water reaches the float, I, and, elevating it, lifts a valve in the top of the case, A, letting out the compressed air remaining in it, so that the internal and external water-levels agree.



As the tide recedes, the air, at atmospheric pressure in the pipe, and upper part of the case, becomes rarefied; and whilst the external atmospheric pressure forces a fresh supply of water up into the lowest chamber, B, by the pipe, J, the external atmospheric pressure on the surface of the water in the open cisterns forces the fluid in them a step higher, into the next higher closed cistern, D, by pipes, one of which is at L. This water is again transmitted, as before, to the open reservoir next to it; and again to the next closed one, until it reaches the last open one of the series, whence it is discharged by a pipe, K. In this way, each rise of the tide discharges a quantity of water equal to the capacity of one of the chambers. The height to which it is raised is determined by the number of chambers employed.

G. P. Purssglove.

Romsey, Hants, June, 1850.

REMARKS ON RAILWAY ENGINEERING.

It may seem presumptuous for an unknown correspondent (not an engineer) to have anything to offer on the above subject, but I pray you, in your editorial capacity, not to be too severe upon me, and to judge my remarks mercifully, seeing they are proffered for the information and advantage of others. When I see so many professors and unscientific men treating of matters, in bulky tomes, of which they are profoundly ignorant, and reflect again upon the mass of useless matter annually published and called science, I feel no hesitation in sending you my thoughts, knowing they are the results of observation and common sense.

More than twenty years ago, when railways for the transmission of passengers and goods were first thought of, it was proposed by Thomas Gray and others, that they should be constructed quite straight from station to station. This plan was then, and is now, admitted by all engineers to offer the greatest advantages in point of safety with high speeds; but it has not been followed, because of the immense expenditure which it would involve. The result is, that our railways are in general curved, and in some cases inordinately so, on which account great care is required in traversing them; and the signboards containing directions to slacken speed, so often noticed by travellers, are rendered essentially necessary. I am not alone in my opinion, that many terrible accidents have been occasioned, directly or indirectly, by these curves. A heavy train in motion at a high velocity has a tendency to progress in a straight line, as no one will deny; and hence it follows, that the strain upon the rails at all curves will be great in proportion to the speed and curvature, and when greater than the rails can resist, will wrench them up; or it may so happen that the wheels of the engine will bounce or jump over the rails, in either of which cases the engine and train must leave the line. Now, I will ask, what mechanical contrivances have been adopted to counteract this tendency, and diminish the acknowledged danger? None whatever in this country. At the present day we see engines and carriages all fitted with rigid wheels and axles, without either horizontal, vertical, or lateral play allowed. With this construction it is no wonder that accidents occur; and, considering the high speeds now so frequent, it seems to me marvellous that there are not more. I except here the long carriages and carriage engines lately introduced, where of necessity either some of the wheels have no flanges, or a little play is given to the axles. Now, it appears plain to me that a remedy can easily be applied, which will considerably lessen the inconveniences attending curves, and it is my object and wish to recommend such remedy to the notice of railway directors and locomotive engine-builders, that it may be adopted. The idea of the remedial contrivance is found in the moveable front axle of carriages and cars, and in the oscillating or steering wheel of the defunct highway locomotive, and recently in Mr. Willis's "farmer's engine," lately engraved in the *Practical Mechanic's Journal*. Let the leading wheels of a locomotive run on an oscillating or moveable axle, and they will follow the guidance of the rails, just as the steering wheel of a bath chair or other carriage obeys the steering handle. I firmly believe, that were this plan adopted in all new engines, without any other alteration in engines or carriages, curves might be passed without danger—even without slackening speed. Of course, existing engines cannot be altered; but railway directors could, if they chose, at any moment stipulate with the makers of the engines to construct all new ones on that principle.

The above contrivance was introduced by the Americans, has been found to answer admirably, and is now universally used on their railways. Let not, then, jealousy or vain national pride prevent English engineers copying an American improvement; but rather let us thank them for the invention, and confess its excellence by at once adopting it. This is not the only point of superiority in American locomotive engines—as may be seen by a perusal of Mr. Passavant's very accurate and sensible remarks thereon, lately given in your Journal,—but it is the principal. I allude to the moveable truck, as he terms it, for carrying the two pairs of leading wheels—or one pair as the case may be,—and which undoubtedly is the simplest and best plan that can be thought of for accommodating the engine and train to a curved railroad. I should suppose that to have one pair of leading wheels moving on a pin or swivel joint would be sufficient, though perhaps large engines would be steadier with two pairs. Sound reasoning convinces me that this alteration would be judicious; long practice in America confirms it; and I hope to see it before long followed in this country.

I consider that Mr. Passavant has rendered your readers and engineers generally, good service by his description of the American locomotive as it is, and feel sure his remarks will command the attention they deserve. While the English ought to be glad to improve themselves by the experience of their brother Americans, the Americans would—I should say—feel proud and honoured to find any of their inventions put in practice by their fathers at home, from whom they have received so many benefits; and I may say that great praise is due to the Editor of this Journal, for inserting the communications in question, because such condescension shows a spirit of liberality as praiseworthy as rare. I consider the American engine framing to be very soundly constructed, and should be glad to see more attention paid to this part here; being convinced that a stronger frame in some cases could be made with less metal—that is, by putting the strength where the strain is felt. As for minor details they do not seem of great import; and since I admire most of the English engines, and know them to be well constructed and beautiful machines, I would principally direct attention to the two forementioned points—the moveable axle for the leading wheels, and a better proportioned framing; believing, that by the one alteration the danger of railway travelling may be lessened, and by the other, the power of the locomotive increased.

And now a few words on the posing subject of "the resistance of the air to railway trains," so much discussed and disputed about of late years. It is amazing what an amount of money and labour has been devoted to the investigation of this matter; and with what result? why, not a jot more is known about it now than formerly. Supposing it were of any consequence to ascertain the exact amount, can it be discovered from the experiments of any one that has essayed to find it? Far from it; all their results vary; and besides, no two experiments by the same experimenter agree. This is not wonderful when we consider the matter in all its bearings rightly, for I boldly assert that its amount can never be ascertained. That there is a resistance caused by the air I cannot deny; but, in the first place, the exact surface of a train exposed cannot be found; and in the second, it is utterly impossible to measure the pressure of the air, for two reasons,—firstly, because a perfect vacuum cannot be obtained in which the train could progress free from all atmospheric resistance, and so the difference could be calculated; and secondly, it is evident to the senses that the pressure is ever changing, and, moreover, that in an experiment, if the pressure and speed be supposed invariable, the actual resisting pressure upon the train will vary according to the angle at which the wind strikes it—that is, the maximum pressure will be when the wind blows right in the face of the engine; and the minimum, when it blows right against the back of the train. I have only to refer to the published results, rules, and formula, of several talented gentlemen, and to point out their discrepancies, in order to prove, what reason teaches me, that it is utterly impossible to ascertain even the resistance of the air, setting aside other resistances, to railway trains. It is very fortunate that it is not necessary to know these resistances; and hence, seeing the utter uselessness of such knowledge, and the impossibility of its acquirement, I should be glad to see the matter dropped. If I can only convince you, Sir, of the truth of my observations, I shall be satisfied. The air cannot be removed, and therefore it must be useless to know its pressure against a carriage or train; and since no unvarying result and no practical benefit can accrue from such investigations, why should they be continued? Common sense tells us, that the less any exposed surface is, the less will be its resistance to motion; and hence it is advisable to have all railway, and all other locomotive, carriages as snug and compact as possible, to diminish their draught and increase their speed. But I think trains move fast enough at present, without devising means to augment their speed. Mr. H. Bessemer is the only person that I know of who has taken a practical view of the subject, and devised means further to lessen the resistance; but I hesitate not to say, that such additions are unneeded, and that their utility is not sufficient to justify their expense. I shall be excused, I hope, for expressing my opinions so plainly; but I am sorry to see scientific men giving their attention to matters so useless.

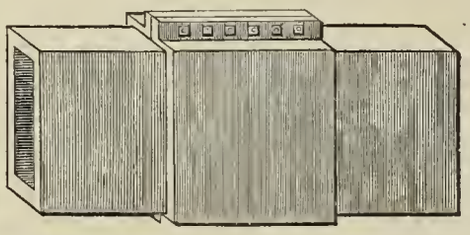
Iron bridges have of late years been much in favour, and their number and excellence in England alone is quite surprising. Of these, the straight girder bridges form a large proportion, from their adaptation to wide spans and low openings. Cast-iron has been principally used, but now, owing to the facilities in making wrought-iron, the latter is judiciously employed for all long bridges. But yet cast-iron girders are, and will be, much used in all practicable cases; and it is therefore of importance to determine their best form. Preference seems generally given to beams of the inverted T or ⊥ section, variously modified; but I doubt if it is the best. We have lately seen most wonderful results arise from the use of hollow wrought-iron girders—a construction so sound and secure, that the limit of their safety seems only to be defined by the practical difficulties of erection. From the experiences of those practically engaged in their construction, we learn that the strongest form is rectangular; which configuration gives so much strength, that engines and carriages even run through them! It has also been proved, that the more the depth exceeds the width, so much the more is their strength

increased; and thin sheet-iron, placed edgeways and properly supported, has been found strong enough for the joists of floors. It is, then, by an application of all this knowledge, and a little invention, that I have been enabled to devise a new girder, which I now submit for your opinion.

The principle of this new girder is to employ hollow beams of cast-iron; their sectional form, in all cases, to be rectangular, either square or oblong. The thickness of the square beam to be equal throughout, but the oblong one to have the narrow ends thicker than the sides. It would appear, from the results of experience and experiments, that the greatest strain is upon the upper and under sides of any beam, supported horizontally, and carrying a load; and therefore the top and bottom of a hollow beam should be stronger than the sides; and again, that the bearing strength increases with the depth, consequently the deeper any beam is, so does its strength increase, without requiring extra width. It must be understood that the oblong hollow beam is always to be placed on edge, to give out its maximum strength. The best proportions of depth, width, and thickness, can only be ascertained by trial. I imagine this species of girder will be found equally as suitable for the joists of buildings, as for the longest and heaviest bridge girders. Being simply a plain oblong tube, it will be easy to manufacture, as the core can be readily made; and, as regards the length, the only limit will be the difficulties of casting; for its length might be increased indefinitely, if practicable, without failure of strength, provided its other dimensions be proportionally enlarged.

Fig. 1.

Fig. 2.



But one great advantage attending this form of girder will be the facility of joining two or more together, and the security of the joint. A plug of wrought-iron, made to fit the inside aperture, is wedged into the end of one beam, and the other is then slipped on the projecting plug till it abuts against the end of the first beam, the ends of both having previously been made smooth and square. Then, over the joint are placed two stout wrought-iron clips, extending an equal distance on each side the point of junction of the beams, which embrace them closely, and are drawn together by screws and nuts on the top and bottom of the beams. A transverse section is shown in fig. 1, and an external perspective elevation in fig. 2. The beams would most certainly be stronger at this joint than elsewhere. The simplicity of such joint will appear, when it is considered that no flanges are wanted, nor any alteration in the form of the beam.

Again, I consider the rectangular ends are well suited for fixing in the brickwork or masonry; and the girders may be placed close together—in contact, if thought desirable. No tension rods of any kind would be needed, and their flat tops give every facility for laying the roadway firmly. This form of girder appears to me to offer several advantages, and, in fine, to afford the greatest strength with the least metal, of any devisable shape. It also appears that it can be manufactured with much facility. I certainly should like it to be tried in practice, to discover if it would bear out its apparent good character.

IRON.

Birmingham, June, 1850.

[Although we have taken the liberty of cutting down our correspondent's remarkably lengthy communication, there is still room for suspicion that it may be found prosily dull. If so, it is possible that this very feature will protect it from the severity of treatment which the writer dreads. Perhaps on one point we may give him a hint. He objects to all discussions and experiments as to the "resistance of the air to railway trains;" and very satisfactorily (to himself) "puts down" the matter, by assuring us that none of us know anything about it, and that, as the resistance cannot be removed, we need not trouble ourselves by running after a shadow. Had our correspondent read more, he would have written less.—ED. P. M. JOURNAL.]

RUTHVEN'S STEAM-SHIP PROPELLER.

I observe, in your last number, a notice of Ruthven's propeller, from which there is reason to fear that their mode of applying the propelling power is not generally understood. The principle of the invention is a perfectly sound one, and was acknowledged and established by Sir Isaac Newton; though, indeed, the sanction of a great name is not required for the confirmation of a hydrostatic principle so readily susceptible of proof as that of the "quaquaversus" pressure of fluids; in plainer terms, the equal and opposite pressure of fluids on the sides of the vessels which contain them. That the economical application of this principle is the substance of Messrs. Ruthven's invention, does not appear to have been understood by many who have undertaken to criticise it. Yet, a pressure of this sort is the motive power that actuates not only Ruthven's propeller, but also Barker's mill, Whitelaw's mill, and the turbine of Fourneyron. Imagine a tall vessel full of water, with an aperture of a given area, near the base, plugged up. The pressure of the water upon the plug is a certain quantity, regulated by the depth of the body of water superincumbent. The hydrostatic pressure on a surface of equal area directly opposite the plug is also a certain amount, and is equal and opposite to that which acts upon the plug. Now, draw the plug, clear the aperture, and the water in the vessel, not being kept in its place by the plug, rushes out. But while there is an expenditure of water by the plug-hole, there exists, in the same condition as before, the pressure on the opposite side of the vessel, already specified. Moreover, it is an *unbalanced* pressure, because the pressure on the side of the vessel, which was borne by the plug, has now vanished; a rush of water, in short, has taken its place. It is plain, then, that the power obtained by this and similar means, does not reside in the effluent water, as some half-bred mechanics have gratuitously assumed; it resides exclusively *within* the vessel—it is the unbalanced pressure. The term *reaction*, it is plain, is a misnomer. It implies what never existed—a potentiality, in virtue of which the water strikes against air, or water, or some other medium, which enables it to rebound or react upon the vessel from which it flows, after the manner of Brunton's hybrid two-legged locomotive. If we suppose the tall vessel referred to, to be suspended by its upper end, with a freedom for pendulous motion, the unbalanced pressure will push the vessel aside, and the angularity of its position will, of course, be regulated by the relative weight of the vessel, and the degree of the pressure. If, again, the vessel be supposed to be attached to the hinder part of a railway carriage, the water may be delivered behind the carriage, and the consequent unbalanced pressure will be available for propelling the carriage.

It follows, too, from this very elementary discussion, that the term *jet* is also inapplicable to the method of the emission of water for procuring power. The velocity with which the water is discharged forms no part of the virtue of this method. A high velocity is, indeed, detrimental, as the maximum work attainable is realized only when the speed of the receding vessel is equal to that with which the water leaves the orifice; should the water issue with a higher velocity—a state of things which is, of course, implied by the term *jet*—a certain proportion of the available power is superfluously spent in projecting the water into space. In applying the pressure which accompanies the discharge of water by orifices, it is, therefore, plainly a condition of its economical application, that the areas of the orifices should be such as to deliver the water at a suitable velocity, according to the speed contemplated, and such as to yield a sufficiency of propelling pressure. These are considerations with which jets have nothing to do.

Throughout the foregoing remarks, nothing has been said of the relation between the volume of water discharged and the quantity of power produced. It is very simple: by reference to our tall vessel, which we presume to have been kept constantly full of water, the power developed by a fall of water is precisely that which, duly applied, would be capable of raising the same weight of water to the height from which it falls. Similarly, by withdrawing the plug of our vessel, and permitting a discharge from it, if the vessel be kept at rest, the water will develop a quantity of work sufficient to raise itself to the height of the level under which it existed in the vessel.

But I shall not dwell longer on this point, as I have no intention of chopping up science for the million. I wish merely to remove some of the grosser misconceptions, which appear largely to prevail, of the nature of the power derivable by effluent water. Ruthven's propeller has been very successful where it has been applied, and I am convinced it only requires a wider and a fairer field to insure a better reception. I hold it to be of small importance, as a matter of argument, that Ruthven's propeller has remained so long in abeyance, though, really, the argument, what is of it, is good both ways. Ruthven's hydraulic mechanism is so diverse from all that has been employed for previous propellers, that none but a young and unformed establishment can be expected to be concerned with it. There are few scheming mechanical engineers, and to a manufacturing business, alteration of plans are costly, and sometimes ruinous, speculations. On the other hand, the excellence of Ruthven's plans, their efficiency and simplicity, may be a very conceivable reason for neglect on the part of engine-makers—for these parties are manufacturers, not professional men; their province is to make, not to contrive; and, for the same reason that the best part of a Christmas book is fre-

quently found in the material which fills the eye, engine-makers will "fill up and fetch more," and will introduce every scrap of iron, of colourable utility, so long as the demand exists.

I perceive that Bodmer's propeller is confounded with Ruthven's. Without detailing, it may be stated simply that Bodmer discharged the water *below* the water-line, while Ruthven discharges *above* the water-line. These are essential distinctions. Bodmer misapprehended the principle; and, incidentally, his fans were water-logged and inefficient. Professor Jeffrey, of Glasgow, committed a more confounded blunder: he combined the exploded fallacies of the jet and the reaction, by forcing the effluent water at a high velocity through a small orifice, and under the water-line.

I believe that steps are being taken for a more vigorous prosecution of the hydraulic system of propulsion by the Ruthvens, and it is hard to understand how they should not be as successful in their applications of that modification of power to purposes of navigation, as Mr. Whitelaw and others have been in their machines for land purposes. Should you deem this communication of sufficient interest to your readers, I shall feel obliged by your inserting it.

D. K. C.

3d May, 1850.

[Shakspeare's admirers are unanimous in the opinion, that the great dramatist "wrote out of the fulness of his heart," and not for the mere purpose of filling a theatre. Should "D. K. C." be happy in the possession of a coterie of venerating disciples, we can fancy *their* determining that the sage proprietor of these three initials pours out his thoughts from the overflowing repletion of his head.

What, for example, are we to make of his raving about the term "reaction?" If he could see clearly into the depths of his "tall vessel," he would find that a pressure equal to *twice* that which acts upon the plug is required to *retain the vessel at rest*—one-half of this pressure being caused by the *weight* of the acting column of water, is equal to that which acts upon the plug—the other arises from the pressure necessary to *keep the jet in motion*. The motion or velocity of the jet or issuing stream, is maintained by the action of a column of water of the same weight as that which acts upon the plug; and, therefore, the reaction of the jet, or its equal, the power required to keep it in motion, is transferred to the area opposite to the jet orifice, and thus the reactive pressure, as well as that due to the height of the water in the vessel, acts on the area opposite to the hole. Then he has a quibble on the poor monosyllable "jet." Let us take the speed of a steamer to be 16 miles per hour, or, what is the same thing, 23½ feet per second—that is the velocity due to a head pressure of about 9 feet of water—may we ask "D. K. C.," in all humility, what would be the area of the jet orifice, with the size of pipe and pump to supply it, the actuating steam-engine being 500 horses' power, if the jet issued at the given speed, as he alleges it ought to do? Again, how much smaller than the greatest, medium, and least cross section of the portion of the vessel below the water-line, would the orifice be? If he takes Cocker, and borrows a slate for the profound calculation, we suspect he will come to the conclusion that, unless the water be made to issue at a speed immeasurably greater than that upon which he has fixed—and unless, in addition to the hydrostatic pressure, he can get a large amount of reactive pressure—the jet principle cannot, at present at least, be economically applied for the propulsion of steamers.

We have the best possible reasons for asserting that "D. K. C." never saw Bodmer's propeller, yet he blindly rushes into a charge against us of confounding this plan with Ruthven's. We need hardly add, that the story of the "water-logged and inefficient" fans, is deserving of just so much credence as attaches to the remarks of one who presumes to write about what he has never seen, and does not comprehend. Let us take the case of the ordinary reaction wheel—"D. K. C." may invent his own name for it. If we discharge the water under the tail water-level, the arms being immersed, we lose just so much power as is necessary to force them through it; but, in a steamer, it can make no difference whether the discharge is above or below the water-line, as the steamer must itself be forced through the water. In point of fact, as the discharge-pipes could thus be kept lower down in the vessel, it would be preferable, in practice, to discharge below the water-line.

The self-complaisant tone of "D. K. C.'s" elementary lecture on hydrostatic pressure, and the elegance with which he "lets himself down" to the comprehension of his readers, are amusing enough, and will be duly appreciated by those who like a dash of nonsense in their literary pabulum. He evidently possesses an extensive growing crop of science, which, despite his modesty—save the mark!—he is ready at all times to chop up "for the benefit of the million," to any extent, and on the shortest notice. When he chops up another mess, we trust he will select and mix his materials better.—Ed. P. M. Journal.]

EXPANSIVE STEAM-ENGINES.

I should be much obliged to you, if you or any of your correspondents would furnish me with the rules for calculating the power of engines when working expansively, through the medium of your valuable Journal. A good practical paper upon this subject would be of the greatest utility, provided the rules are written down in decimal arithmetic. I have consulted different authors, but they vary so much, and dress their rules up in algebraical formula to such an extent, that it is perfectly unintelligible to many working men. The reason I desire to know from you, or any of your correspondents, is because I am compiling a practical work for myself. Mr. Passavant's papers on English and American locomotive engines are the most interesting papers I have read for some time, and I hope you will shortly oblige us with drawings of some of the most improved American locomotive engines.

A Subscriber.

Manchester, June, 1850.

DIFFERENTIAL SLIDE MOTION FOR LATHES.

As there may be others, as well as myself, who do not understand how the differential motion, treated on in your two last numbers, is to be applied, I should feel obliged if Mr. Muckelt would favour us with an explanation of the manner in which the spiral is to be attached to the slide-rest; also, how it acts upon the screw.

C. E.

London, June, 1850.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

May 14, 1850.

William Cubitt, Esq., President, in the Chair.

"On the Construction of the Permanent Way of Railways, with an Account of the wrought-iron Permanent Way, laid down on the main line of the North Midland Railway," by Mr. W. H. Barlow.

The author commenced by entering into the question of the maintenance and renewal of the ordinary railways, analysing very minutely the expenses under the different heads, and showing to what causes the derangement of the line might be attributed. The cost of maintenance was stated to be dependent on two causes,—the effect of weather, &c., and the disturbance produced by traffic; and from a summary of the expenditure of the different lines belonging to the Midland Company, it appeared that the former amounted to £20 or £30 per mile per annum, and the latter varied from 2d. to 2s. 7d. per train per mile. After a line was consolidated, by far the greater part of this expenditure was due to the derangement caused by the passage of the trains, which first produced an uneven joint, then loosened the joint-key, and then disturbed the sleeper, so that at length the whole of the permanent way generally was degraded.

With regard to renewal, it had been estimated by the officers of the London and North-Western Railway, that, on their line, the rails would last twenty years, and the sleepers, if "creosoted," twenty years, but if unprepared, only twelve years. Now, as the duration of service of the rails was dependent on the amount of the traffic, and that of the sleepers on the weather, it was quite evident that, on lines having less traffic than the London and North-Western, the proportionate expense of renewing the sleepers would be much greater, and would increase as the amount of traffic diminished.

In endeavouring to seek a remedy for this, the author conceived, that, by increasing the dimensions of the bridge rail, sufficient width might be obtained for it to take its own bearing in the ballast, without the use of either transverse sleepers or longitudinal supports; and, moreover, that such a construction would possess great strength, be very durable, and be capable of being renewed at a moderate expense. He therefore proposed a bridge rail, 13 inches in width, 5¾ inches in depth, and weighing 126 lbs. per lineal yard. There was some difficulty at first in getting it manufactured, but Messrs. Bolckow and Vaughan, of Middlesborough-on-Tees, had overcome all the practical difficulties, and now produced rails of the required size, with hard metal in the upper portion, and ductile metal in the lower, by which both durability and strength were insured. The joint was made by either a cast or wrought-iron chair, or saddle, which received the ends of the rails, and into which they were keyed with wooden keys. The guage was preserved by means of a tie-bar, fitted and keyed into sockets on the chairs.

An experimental length of road on this construction had been laid down on the main line of the North Midland Railway, the cost of which was £3,323 per mile:

but it was thought that in future this might be reduced to £2,487 per mile, by reducing the weight of the rails to 100 lbs. per yard, and the chairs in proportion, as it was found by experiment that these rails were greatly in excess of strength, being as much as three times stronger than that of the ordinary double-headed rail.

A mile of road had also been laid upon the same line. with cast-iron sleepers adapted to the ordinary rail, as introdueed by Mr. P. W. Barlow, M. Inst. C.E.; and another mile had been laid with these east-iron sleepers at the joints only, but having intermediate sleepers of timber.

The motion of the trains over their several experimental lines was firm and steady, there being no perceptible differenee betwcen the two latter descriptions.

In the diseussion which ensued, in which Messrs. Hawkshaw, Brunel, Locke, M.P., P. W. and W. H. Barlow, and Glynn, took part, the relative advantages and disadvantages of the different systems of permanent way in present use were discussed, and also, in some slight degree, compared with that proposed by Mr. W. H. Barlow; but it appeared to be a general opinion, that no one system of laying a permanent road could at present elaim a great superiority over any other; and that, in reality, much more depended on the good quality of the materials used in its construetion, than in any particular way of laying it. The objects to be attained were—simplieity of construetion, so that there should be as few parts as possible to get out of order, a perfeet joint, and economy of maintenance; and though the two first of these desiderata were admitted to be obtained in a permanent way with bridge-shaped rails and longitudinal timber-sleepers, it was contended that they were, to some extent, counterbalanced in a road laid in the ordinary manner, with double-headed rails and cast-iron chairs, as, in some instances, after being turned, the second table was found to be more durable than the first.

May 21.

"On Printing Maehines; espeeially those used in the printing of the *Times* newspaper," by Mr. Edward Cowper.

The object of this paper was prineipally to describe the machinery whieh had been in use, at various times, for printing the *Times* newspaper, other machines being only referred to, as assisting to illustrate the subject.

For this purpose, a brief review of the progress of printing machinery was given, from which it appeared that the first patent was obtained by Nicholson in 1790, who then proposed plaeing both the types and the paper upon cylinders, and distributing and applying the ink also by means of eylinders; another plan was to place common type upon a table, which was passed under a paper cylinder. In 1813, Donkin and Baeon proposed placing the type upon a prism, and introduced "composition" rollers. In 1816, Cowper made a machine to print from curved stereotyped plates, and in 1818 one to print books from ordinary type; he also introduced the system of inking now in common use. In 1814, Kœnig made the first working machine, and erected two of these at the *Times* offiee, whieh produced eighteen hundred impressions per hour, and continued to do so until 1827, when they were superseded by Applegath and Cowper's four-cylinder machine, produeing five thousand impressions per hour.

These machines, which were stated to be still in use at the *Times* office, consisted of a table moved backwards and forwards under four iron cylinders (called the paper cylinders), about nine inches in diameter, which were covered with cloth, and round which the sheets of paper were held between tapes. The form was fixed on one part of the table, the inking rollers lying on another part, on which they distributed the ink; some of these rollers were placed in a diagonal position on the table, so that, as it moved backwards and forwards, they had a motion in the direetion of their length, ealled the "end-motion," which, combined with the rotatory motion, caused the ink to be more effeetually distributed. The ink was held in a reservoir or trough, formed of an iron roller, called the duetor, against which the edge of an iron platc rested, and, by its pressure, regulated the quantity of ink given out. The ink was conveyed from the duetor-roller to the table by means of an elastie roller vibrating between them. The feeding was performed by four "layers-on," who laid the sheets of paper on the feeding boards, whence they entered the machine between three pairs of tapes, by which they were conveyed round the cylinders, and thence to the spot where the "takers-off" stood, into whose hands the sheets fell, as the tapes separated.

In May, 1848, the last great improvement was introduced, when Mr. Applegath ereeted, at the *Times* offiee, a vertical machine, whieh was stated to produee the enormous number of 10,000 impressions per hour. This machine eonsisted of a vertical eylinder, about sixty-five inches in diameter, on which the type was fixed, surrounded by eight other eylinders, each about thirteen inches in diameter, covered with eloth, and round whieh the sheets of paper were eonveyed by means of tapes; each paper eylinder being furnished with a feeding apparatus, having one boy to lay them on and another to take them off. The inking-rollers were also placed in a vertieal position, against the large cylinder, upon a portion of the surfaee of which they distributed the ink. The ink was held in a vertical reservoir, formed of a duetor-roller, against which rested two "straight edges," connected at the back, so as to prevent the ink from running out: it was conveyed from the duetor-roller by one of the inking-rollers, against which it was occasionally pushed.

The type used was of the ordinary kind, and the form was placed upon a portion of the large cylinder, being fixed to it in a very plain but ingenious manner: a slab of iron was eurved on its under side, so as to fit the large cylinder, whilst its upper surface was filled into faeets, or flat parts, corresponding in width and number to the width and number of the columns of the newspaper; between eaeh column there was a strip of steel, with a thin edge, to print the "rule"—the body of it being wedge-shaped, so as to fill up the angular space left between the eolumns of type, and to press the type together sideways, or in the direction of the lines; the type was pressed together in the other direetion by means of screws, and was, therefore, firmly held together. The surface of the type thus formed a portion of a polygon; and the regularity of the impression was obtained by pasting slips of paper ou the paper cylinders.

The operation of the machine was very simple: the "layer-on" drew forward a sheet of paper on the feeding-board, until its edge was under a roller, furnished with tapes, which dropped down and drew the sheet forward and downward, into a vertical position, when other rollers and tapes carried it round the paper cylinder, when it met the type, which had been inked by passing in contact with the inking-rollers; the sheet then continued its progress until it reached the "taker-off."

Some interesting statistics, relative to the printing of the *Times*, were mentioned, from which it appeared, that, on the 7th of May, 1850, the *Times* and supplement contained 72 columns, or 17,500 lines, made up of upwards of a million pieces of type, of whieh matter about two-fifths were written, eomposed, and corrected after 7 o'clock in the evening. The supplement was sent to press at 7.50 P.M., the first form of the paper at 4.15 A.M., and the second form at 4.45 A.M. On this oeeasion, 7,000 papers were published before 6.15 A.M., 21,000 before 7.30 A.M., and 34,000 before 8.45 A.M., or in about four hours. The greatest number of copies ever printed in one day was 54,000, and the greatest quantity of printing in one day's publication was on the 1st of March, 1848, when the paper used weighed 7 tons, the weight usually required being 4½ tons. The surfaee to be printed every night, including the supplement, was 30 aeres; the weight of the fount of type in constant use was 7 tons, and 110 compositors and 25 pressmen were constantly employed. The whole of the printing at the *Times* offiee was aetually performed by three of Applegath and Cowper's four-cylinder machines, and two of Applegath's new vertical cylinder machines.*

May 28.

The Sessional Meetings were appropriately terminated this evening by a Conversazione, given by Mr. Cubitt, the president, at the house of the Institution. The guests were reeeived by the President, supported by the principal members of the Council, and assisted by Mr. C. Manby, the secretary, on whom devolved the selection and arrangement of the models and works of art, as well as the deeorations of the rooms, and the direction of all the proceedings of the evening; and certainly, when it is considered that nearly a thousand visitors passed through the rooms in the course of the evening, with so mueh ease and comfort, it is as much a subject of astonishment how it was aeeomplished, as of admiration for the general system and arrangement adopted.

The rooms were excellently decorated, all the windows and the staircase being lined with choiee flowers, and the portières draped with beautiful Aubusson tapestry, sent by Monsieur Sallandrouze de Lamornaix, who also eontributed several beautiful works of art for the drawing-room tables.

The walls were covered with paintings; among which were three well-known Edwin Landseer's, "Diogenes," "Shoeing," and "Dignity and Impudence,"—the two latter contributed by Mr. Jacob Bell, who also spared from his eolleetion pictures by Etty, Frank Stone, and Wilme; the other pictures were by Oliver, Fahey, Wood, G. Landseer, Herring, O'Neill, and others.

Mr. Mitehell sent a beautiful Watteau, and some delicious French crayon drawings; and the tables were eovered with portfolios of sketehes by Lake Price, Mr. and Mrs. Oliver, H. Johnson, Nash, and others.

Two extremely curious illuminated Holy Books of the Sikhs, contributed by Mr. Edgar Bowring, excited great attention; as did some splendid speeimens of Chinese Ivory Carvings and of Silver Chased Work, brought from Ceylon by Sir Emerson Tennent, and which were appropriately displayed on a fine carved oak sideboard, by Mr. J. Thomas.

Messrs. Elkington contributed a fine colleetion of Electro-deposit works in gold, silver, and bronze; Messrs. Minton, Encaustic Tiles; Mr. Essex, Enamel Paintings; Mr. Le Molte, remarkable Alto-relievo Groups; and Mr. Mayall, fine Daguerreotypes.

The meehanical models were very numerous, and well arranged. Space will only permit a few to be mentioned. Of those at work, Mr. Cotton's ingenious maehine for weighing and seleeting heavy and light gold eoins, with the accompanying turbine for giving motion to it, was, perhaps, the most generally interesting.

Mr. Barker's Curvilinear Sawing Maehine; Mr. W. S. Johnson's American Printing Press; Mr. Appold's Register Hygrometer and Thermometric Balance; and Mr. Whishaw's Printing Telegraph, worked by magnets, being in action, attracted much attention.

Of the other models arranged around the room, the following may be mentioned:—Mr. John Penn's models of Freneh Engines, and of Oscillating Cylinder Engines; Messrs. Maudslay's Feathering Paddle-Wheels; Captain Fayrer's Improved Steering-Wheel; Siemens' Condensing Apparatus; Symon's Weighing Crane; Mitehell's Screw Pile for Lighthouses, Ships' Moorings, &e.; Smith's Yielding Breakwater and Lighthouse; Ransome and May's Agricultural Implements; Anthony's New American Churn; Soyer's New Portable Cooking Apparatus; Edge's, Crosley's, and other Meters; Chubb's Locks; Moxon's Imitations of Wood and Marble; Perigal's Ellipsograph; Lémolte's Batteries; Lerebour's Optical Instruments; Fahey and Green's Folding Models; Brunton's Mine Ventilator; Martin's Improved Sewage Flaps; Marsden's Gully Trap; Sheringham's Ventilators; Wilkins' Dioptric Light Apparatus for Light Ships; Shepherd's Balloons for the Aretic Regions; Warriner's Deflectometer; P. and W. H. Barlow's Permanent Way, and

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* For additional information on the *Times* machine, see p. 248, vol. 1, and p. 99, vol. 2, *Practical Mechanic's Journal.*

Saltometer; Ransome and May's Compressed Trenails and Wedges; Specimens, from Low Moor, of Raw Material and Iron in all stages of Manufacture; and of Stirling's Toughened Iron; Turner's Iron Roof of 154 feet span at Liverpool; Cubitt's Roof for the Goods Station at the Great Northern Railway; and numerous specimens of Gutta Percha, adapted to new and useful articles.

The centre of the room was occupied by Dighton's model of Gatton; Jee's models of the Dinting Vale Viaduct, and of the Goods Station of the Manchester, Sheffield, and Lincolnshire Railway; Fowler's Torksey Bridge, &c., &c.

In the anti-room were Donkin's new application of the Disc Engine; Chubb's Iron Safe; and Jobson's clever and simple Reflecting Stove.

SOCIETY OF ARTS.

PRESIDENT—H.R.H. PRINCE ALBERT, D.C.L., F.R.S., &c.

WILLIAM FOTHERGILL COOKE, ESQ., VICE-PRESIDENT, IN THE CHAIR.

FEBRUARY 13, 1850.

"On the Present Condition of Art, as applied to Calico Printing," by Mr. G. Wallis.

The author commenced by referring to the paper read by him to the Society last session, in which he endeavoured to trace out the past progress and present condition of calico printing, so far as related to the mechanical and chemical departments; and then proceeded to give a general outline of the subject, and to call attention to a series of illustrative specimens, showing the limits to which design is subject when applied to particular fabrics.

The mechanical means generally employed in printing calicoes are blocks and cylinders, and the colours are "madders" and "steams." Of the class of fabrics on which steams are usually employed, mouselline de laine was mentioned as a type; while the prints usually known as Hoyles are distinct examples of madders. The madder dyes, properly executed, are essentially fast, and the tints are only to be reduced by repeated boilings and washings, a course frequently taken by the printer to get his colour down to the desired hue. The fast colours are the following:—red, ranging in tint from dark crimson to light pink; purple, ranging from the darkest tint to the lightest shade; chocolate, brown and black. Besides these madder colours there is a fast blue, produced from indigo and catechu brown; thus, with the exception of yellow, and, consequently, green of a brilliant tint, the range of fast colours is complete.

In steams there is a wider range of colours, including green, yellow, orange, &c.; in de laines these may be considered as fast, wool having a much greater affinity for colouring matter than cotton.

The author next proceeded to call attention to the nature of the designs suitable for madders; and first referred to mill-work, in which each roller is necessarily limited in size from two and a half to four inches in circumference—this gives the size of the repeat of the pattern. The class of designs best suited to this process of manufacture is that of stripes, as they are easily engraved and readily printed. Striped patterns should be varied, not so much in form, as in disposing the groups upon them.

The artistic effect of the details is only limited by the number of cylinders; but the author is of opinion that the most agreeable effects can be produced by two or three tints, as true artistic feeling is quite consonant with simplicity in materials.

The author next referred to the extent to which the effect of relief might be successfully carried. The best art is that in which the art is most concealed. On seeing a lady's dress, or a furniture print, the sentiment of the whole ought to strike us, without any portion being so obtrusive as to cause special inquiry as to what it is, or how it is produced.

Of the effects producible in madders, the monochrome is the most suitable. A flat relief is very effective for half-mourning. All the various processes of engraving are applicable for the production of different effects: where the repeat is small, mill-work is used; where it is large, the cylinder is engraved all over by hand, and a "cover" added by the etching process.

Steam colours constitute the great mass of productions in calico printing, particularly for the foreign trade. The range of these colours capable of easy introduction offers a great temptation to the designer to supply his want of artistic effect by showy vulgarity; and thus, while madders are usually confined to two or three cylinder machines, steams occupy as many as four, five, six, and, in some instances, seven cylinders.

The author then cautions designers against crowding their patterns for the sake of introducing several colours; and showing by examples that freedom of treatment is compatible with perfect accuracy of execution, he further urges the propriety of closer study of nature, both for harmony of colours and for elegance of form: the former shown so variously in the skins of animals, in shells, flowers, leaves, and insects; the latter in the growth, interlacing stems, &c., of grasses and other vegetables, amongst which the ability of the artist in selection and combination will find a wide field for exercise.

The author next glances at what he terms "de laine" effects, including mouselines de laine, muslins, and barèges, all of which he classes under the general head of calico printing. The best specimens are chiefly block-work, which affords a wider range of pattern and a larger number of colours than can be got in mill-work; but five may be said to be about the average. Attempts have been made to combine block with cylinder work, but the effect is rarely satisfactory; and on account of the mechanical difficulty of the combination, and the cost of production, it may now be said to be abandoned.

The author concluded his paper by calling attention to the various specimens and designs upon the walls, and to the new application of printed calicoes to panelling and internal decoration.

Specimens of a new black ink, capable of resisting the action of acids and alkalies, by Mr. Galbraith, were placed on the table and exhibited.

MAY 15.

ROBERT STEPHENSON, ESQ., M.P., VICE-PRESIDENT, IN THE CHAIR.

"On Siemens's Regenerative Condenser," by Mr. C. W. Siemens of Birmingham.

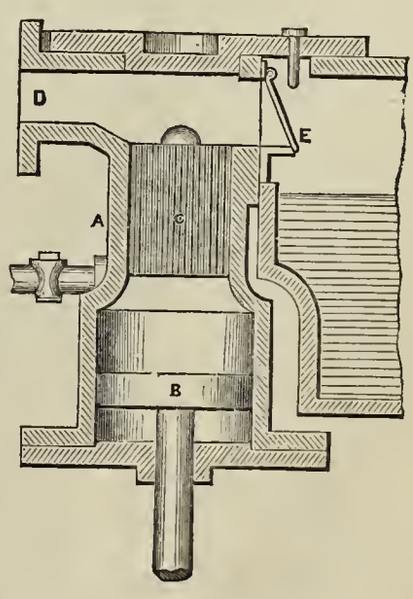
The paper commences with an historical sketch of the condenser of the steam-engine, from the invention of Savery, in which a single vessel served the triple purpose of steam-cylinder, condenser, and water-pump, to James Watt's injection condenser. Hornblower proposed a surface condenser, which was, however, deficient in extent of cooling surface, and therefore failed, as have many others invented since; the most prominent being that of Mr. Samuel Hall, in which the steam was passed through tubes immersed in a stream of cold water. This condenser has the serious drawbacks of weight, costliness, and difficulty of getting rid of the calcareous deposits from the condensed steam.

Three years ago, Mr. Siemens invented his surface condenser for a situation where economy of space and material was essential. It consists of a number of copper plates of $\frac{3}{32}$ inch in thickness, $4\frac{1}{2}$ inches broad, and 2 feet long, which are piled together with two longitudinal flattened wires of the same metal intervening between the adjacent plates, the whole pile being screwed up tight together between the sides of a rectangular cast-iron vessel, constituting the body of the condenser. The ends of the plates project through the top and bottom of the vessel, and are planed flush with its exterior surfaces. The joints are at top and bottom, secured by means of india-rubber rings, screwed down under small cast-iron frames, and which yield to the difference in expansion of the two metals. The flattened wires are laid parallel, and about three inches apart, and form, with the plates, a large number of narrow passages, through which the cold condensing water flows in an upward direction without entering the vacuous space of the condenser, into which the ends of the plates outside the flattened wires—forming the condensing surfaces—project. The heat of the steam is thus passed through the plates, from their edges towards the centre, to the condensing water,—the limit to its efficiency being the conducting power of the metal. Its dimensions are as follow:—

Heat-absorbing surface by the water,	18 sq. feet per horse power.
Condensing surface,	9 do. do. do.
Thickness of metal through which the heat is conducted,	$1\frac{1}{4}$ inch.
Weight of copper,	60 lbs. per horse power.
Space occupied by plates,	·4 cube ft. do. = $\frac{1}{10}$ part of the space occupied by the tubes in Hall's condenser.

Its essential features are—its comparative cheapness of construction, the easy access it affords to the water-channels, and reduction in the quantity of condensing-water required.

THE REGENERATIVE CONDENSER.—The origin of this condenser was the suggestion to the author of Mr. Graham of Mayfield Works, "to recover the heat from the condensing water in the form of a reduced amount of boiling hot water." It consists of an upright rectangular trunk, A, of cast-iron, the lower end of which is cylindrical, and contains a working piston, B, which performs two strokes for each one of the engine. In the trunk is a set of copper plates, C, upright and parallel to each other,—the intervening spaces being the same as the thickness of the plates, viz., between $\frac{1}{12}$th and $\frac{1}{16}$th of an inch.



The upper extremity of the condenser communicates on the side, D, to the exhaust-port of the engine, and on the other, through a valve, E, to the hot well.

The plates are fastened together by five or more thin bolts, with small distance-washers between each plate. There is a lid at the top of the trunk, by removing which the set of plates can be lifted out. Immediately below the plates the injection-pipe enters.

The action of the condenser is as follows:—Motion is given to the piston. At the moment that the exhaust-port of the engine opens, the plates are completely immersed in water, a little of which has entered the passage above the plates, and is, together with the air present, carried off by the rush of steam into the hot well, the excess of steam escaping into the atmosphere. The water then, in consequence of the downward motion of the piston, recedes between the plates, exposing them gradually to the steam, which condenses on them. Their upper edges emerging first from the receding water are surrounded by steam of atmospheric pressure, and become rapidly heated to about 210°. The immersion of the plates still continuing, the steam is constantly brought into contact with fresh cool sur-

face, by which the greater portion of it is condensed, until, as the piston descends, the injection enters and completes the vacuum. This is done by the time the working of the piston of the engine has accomplished $\frac{1}{7}$th of its stroke. The upper extremities of the plates become heated to near 210°, and the lower to about 160°.

Taking the initial temperature of the condensing water at 60°, the final temperature at 210°, the latent heat of steam at 212°, 960 units, the quantity of water required is 6·6 lbs. to condense 1 lb. of steam of atmospheric pressure. The common injection condenser (supposing the temperature of the condensed steam to be 110°) requires 21·2 lbs. in place of 6·6 lbs.

The advantages of this condenser are:—

1. Additional effective power gained on account of the vacuum = 30 per cent., taking the pressure of steam at 40 lbs. above the atmosphere, and vacuum in the cylinder 12 lbs.

2. Heat saved in generating steam by the use of boiling feed-water = 10 per cent. over the ordinary method of heating the feed-water to 110°, or 15 per cent. when no use is made of the condensed water for that purpose.

3. The steam which escapes uncondensed may be used to cause draught.

4. The displacing cylinder takes no motive power.

5. The condenser may be started and stopped at any time by turning the injection water on or off. If turned on, it at once forms the vacuum without involving the necessity of blowing through; and if turned off, it allows the engine to proceed as though it had not a condenser.

6. The air contained in the condenser is at each stroke completely expelled.

7. Greater compactness, and less expense, than the injection condenser.

Its dimensions in terms of parts of the engine are as follow:—Area of plate-chamber = three times that of exhaust-pipe; length of plates = $\frac{1}{5}$ that of stroke of engine; thickness of plates, $\frac{1}{29}$ of their length; spaces between plates same as thickness, but never more than $\frac{1}{16}$th of an inch, as with that dimension no sediment can stand against the rush of water. Capacity of displacing cylinder = that of plate-chamber.

It has been attempted to adapt this condenser to the locomotive; and of the advantages which would be gained if this could be done there can be no doubt. In this case the two condensers were cast in one piece, and placed directly in front of the cylinders. They differed from that just described only in the length of the condenser and stroke of the displacing piston being much shortened, so that the velocity of the water between the plates may not be too great; and in having a second set of discharge-valves of peculiar construction, for allowing the uncondensed steam to pass freely into the funnel. The ordinary supply of feed-water not being by itself sufficient to maintain the vacuum, this condenser, if applied to locomotives, should only be worked at intervals, on inclines, &c., where its assistance would be needed.

In its application to low-pressure engines, since the steam from the cylinder has not sufficient power to force the air and heated water from the condenser into the atmosphere, a communication is made between the exhaust-valve of the condenser, and the lower end of the displacing cylinder, which, for convenience of arrangement, is here reversed, and which receives the charge of water and air when its piston is at the opposite end of it, and when it is therefore vacuous.

In this case the amount of injection water is reduced in the proportion of three to one. Ten per cent. is saved by the feed-water being made boiling hot, a great quantity of boiling water being provided which cannot fail to be useful for many purposes.

The first regenerative condenser was applied to a sixteen horse-power high-pressure engine, at Saltby Works, near Birmingham, in September, 1849, where it has been found to answer. One is now being erected at the Paper Works of Messrs. Easton and Amos, at Wandsworth, and will shortly be in action.

A drawing was exhibited, showing the condenser applied to a common high-pressure engine, in connection with a variable expansion-valve, acted on by a governor, which is a modification of Mr. Siemens's chronometric governor, the pendulum being superseded by an expanding fly-wheel.

The principle involved in the regenerative condenser is applicable to many useful purposes, the most remarkable of which are what Mr. Siemens proposes to call his regenerative evaporater for brine and other liquids, and the regenerative engine, which are now in course of construction, at the works of Messrs. Fox and Henderson, near Birmingham, to whose enterprise Mr. Siemens expresses himself as indebted for the carrying out of his several inventions.

May 22.

William Fothergill Cooke, Esq., Vice-President, in the Chair.

"On the application of Electro-Magnetism as a Motive Power," by Mr. Robert Hunt.

In this paper the author called attention, in the first place, to the numerous attempts which have been made to apply electro-magnetism as a power for moving machines, and particularly described the apparatus employed by Jacobi, Dal Negro, M'Gauley, Wheatstone, and others, noticing incidentally the machines recently constructed by Mr. Hjorth. Since, notwithstanding the talent which has been devoted to this interesting subject, and the large amount of money which has been spent in the construction of machines, the public are not in possession of any electro-magnetic machine which is capable of exerting any power economically; and finding that, notwithstanding the aid given to Jacobi by the Russian Government, that able experimentalist has abandoned his experimental trials,—the author has been induced to devote much attention to the examination of the first principles by which the power is regulated, with the hope of being enabled to set the entire question on a satisfactory basis.

The phenomenon of electro-magnetic induction was explained, and illustrations given of the magnetization of soft iron by means of a voltaic current made to circle around it. The power of electro-magnets was given, and the author stated his belief that this power could be increased without limitation.

A voltaic current produced by the chemical disturbance of the elements of any battery, no matter what its form may be, is capable of producing by induction a magnetic force, *this magnetic force being always in an exact ratio to the amount of matter (zinc, iron, or otherwise) consumed in the battery.*

Several forms of the voltaic battery were explained, particularly those of Daniell, Grove, Bunsen, and Reinsch, the latter being constructed without metals, depending entirely on the action between two dissimilar fluids slowly combining.

The author had, however, proved, by an extensive series of experiments, that the greatest amount of magnetic power is produced when the chemical action is the most rapid. Hence, in all magnetic machines, it is more economical to employ a battery under an intense action, than one in which the chemical action is slow. It has been proved by Mr Joule, and most satisfactorily confirmed by the author, that one-horse power is obtainable in an electro-magnetic engine, the most favourably constructed to prevent loss of power, at the cost of 45 pounds of zinc, in a Grove's battery, in 24 hours; while 75 pounds are consumed in the same time to produce the same power in a battery of Daniell's construction. The cause of this was referred to the necessity of producing a high degree of excitement, to overcome the resistance which the molecular forces offer to the electrical perturbations, on which the magnetic force depends.

It was contended, that although we have not perhaps arrived at the best form of voltaic battery, yet that we have learned sufficient of the law of electro-magnetic forces to declare, that, under any conditions, the amount of magnetic power would depend on the change of state—consumption of an element—in the battery, and that the question resolved itself into this:—

What amount of magnetic power can be obtained from an equivalent of any material consumed?

The following were regarded as the most satisfactory results yet obtained:—

1. The force of voltaic current being equal to 678, the number of grains of zinc destroyed per hour was 151, which raised 9,000 pounds one foot high in that time.

2. The force of current being, relatively, 1,300, the zinc destroyed in an hour was 291 grains, which raised 10,030 pounds through the space of one foot.

3. The force being 1,000, the zinc consumed was 223 grains; the weight lifted one foot 12,672 pounds.

The estimations made by Messrs. Scoresby and Joule, and the results obtained by Œrsted, and more recently by Mr. Hunt, very nearly agree; and it was stated that one grain of coal, consumed in the furnace of a Cornish engine, lifted 143 pounds one foot high, whereas one grain of zinc consumed in the battery lifted only 80 pounds. The cost of one hundred weight of coal is under 9 pence; the cost of one hundred weight of zinc is above 216 pence. Therefore, under the most perfect conditions, magnetic power must be nearly twenty-five times more expensive than steam power.

But the author proceeded to show that it was almost proved to be an impossibility ever to reach even this condition, owing, in the first place, to the rate with which the force diminishes through space. As the mean of a great many experiments on a large variety of magnets, of different forms and modes of construction, the following result was given:—

Magnet and armature in contact, lifting force,		220	pounds.
"	distant $\frac{1}{50}$ of an inch,	90·6	"
"	$\frac{1}{125}$	50 7	"
"	$\frac{1}{63}$	50·1	"
"	$\frac{1}{25}$	40·5	"

Thus, at one-fiftieth of an inch distance, four-fifths of the power are lost.

This great reduction of power takes place when the magnets are stationary. The author then proceeded to show, that the moment they were set in motion a great reduction of the original power immediately took place; that, indeed, any disturbance produced near the poles of a magnet diminished, during the continuance of the motion, its attractive force.

The attractive force of a magnet being 150 pounds when free of disturbance, fell to one-half, by occasioning an armature to revolve near its poles.

Therefore, when a system of magnets which had been constructed to produce a given power is set in revolution, every magnet at once suffers an immense loss of power, and consequently their combined action falls in practice very far short of their estimated power. This fact has not been before distinctly stated, although the author is informed that Jacobi observed it.

And not merely does each magnet thus sustain an actual loss of power, but the power thus lost is converted into a new form of force, or rather becomes a current of electricity, acting in opposition to the primary current by which the magnetism is induced.

From an examination of all these results, Mr. Hunt is disposed to regard electro-magnetic power as impracticable, on account of its cost, which must necessarily be, he conceives, under the best conditions, fifty times more expensive than steam power.

The Chairman agreed with Mr. Hunt in his conclusion of the improbability of any result being obtained from electro-magnetism, which could enable it to compete with steam as a motive power. At any rate, the point to which the attention of engineers and experimentalists should be turned at present was, not the contriving of perfect machines for applying electro-magnetic power, but the discovery of the most effectual means of disengaging the power itself from the conditions in which it existed stored up in nature. Mr. Faraday assured us, that in a single drop of water is contained as much electricity as is developed in a thunder-storm. The

portion of this which we can liberate by any existing battery is very small; so small, that, as shown by Mr. Hunt's paper, its practical use cannot be profitable. The study of electro-chemistry, he thought, was a more promising field, and one from which might, at a future time, be developed a power which should supersede even steam.

Mr. Winkworth proposed, and Mr. Highton seconded, a vote of thanks to Mr. Hunt.

The attention of the meeting was called to a model of a three-roomed labourer's cottage, which had been erected by Mr. W. N. Clay at Harlow, in Essex, at a cost of £10 only. The walls are formed of clay lumps dried in the sun, having an admixture of straw in their composition; the roof is of thatch, and the floor of concrete.

Analogous modes of building, used not only for cottages, but for houses of large size, in Cornwall, Hampshire, and the West of England, were mentioned by several members, as well as the "Pisa-work" used in Italy for churches and large buildings.

A chair, ingeniously composed of 492 small pieces of wood dovetailing into each other, and holding together without either glue or pins, was shown to the meeting. It is the work of a farm-labourer, named Selwood, of Charlton, near Pusey, in Wilts, and was entirely executed by him with a knife.

Mr. Varley, jun., explained his improvements in the air-pump. In place of the two barrels and vibrating intermittent motion of the ordinary pump, Mr. Varley has a continuous circular motion in the handle, and one double-acting barrel. The piston-rod is attached to a crank on the motion-shaft, and the cylinder oscillates from its bottom, a packed joint being most ingeniously done away with by having the tube between the barrel and the receiver coiled spirally, which, by its spring, gives play enough for the oscillation of the barrel. Mr. Varley explained his larger pump, in which there are some ingenious contrivances in addition to those already mentioned. Instead of a valve opening inwards into the barrel by the pressure of the air, as in the old pumps, the valve is worked by an eccentric, and is so arranged as to open a communication between the top and bottom of the barrel at each stroke, by which the rarefaction of the air is doubled. He has obtained, with this pump, a vacuum of $\frac{1}{10}$th of an inch of mercury.

The air-pumps exhibited were made, as well as contrived, by Mr. Varley himself,—a circumstance alluded to by the Chairman, in expressing to him his approbation of the great ingenuity shown in them, and the thanks of the Society for his explanations.

ROYAL SCOTTISH SOCIETY OF ARTS.*

Address by THOMAS GRAINGER, Esq., C.E., President of the Royal Scottish Society of Arts, *on the desirableness of obtaining Communications relative to the construction and details of Engineering and other Public Works, accompanied by the necessary Models and Drawings.*

I am the more desirous to bring this apparatus under the notice of the Society, as it might be applied in raising water for small towns and villages, whose elevations, with reference to the sources from which their supplies may be obtained, are such as to prevent the water reaching the cisterns by *gravitation*, and where the use of engine power would be too expensive. The cheapness and simplicity of the hydraulic ram are recommendations for its application in cases where the required supplies are, as I have stated, inconsiderable, in comparison with the extent of the respective sources.

It would be very important if the same principle could be carried out, by taking advantage of the *rise* and *fall* of tides as the moving power. By this means an abundant supply of sea-water might, in many places, be made available, in this, and many other of our coast towns, for sanatory purposes, and at little more than the cost of laying down the pipes. This would be a most important application of the principle. For instance, the rise and fall of the tide on our own coast would, I believe, be sufficient to raise sea-water with ease to any level below that of the base of the General Register-House. Where the rise and fall of the tide is much greater, as at Bristol and Liverpool, this principle could, of course, be more readily applied.

Water-Power.

There is another class of hydraulic works which appear to me to be of great value to the manufacturing interests of this kingdom, and consequently of national importance;—I mean those by which water-power may be employed *in the working of machinery*. From the countless number of falls which are to be found yet *unoccupied* on many of our large rivers, I regard this as a subject entitled to the attentive observation of every one who is desirous to see our manufactures extended, and more generally diffused over the country. It is, however, essential to the profitable occupation of these falls that they be situated where the raw material and the manufactured articles can be conveyed to and from them at a moderate charge,—an object which the recent improvements in our system of internal communication are well calculated to promote.

In Scotland, the application of water-power has attained greater perfection, and is, I believe, more largely employed, than in any other country of the same extent. We have the river North Esk in this county, upon which there is a great deal of most valuable machinery, giving profitable employment to thousands. The water-power of this stream is being greatly increased by the construction of a reservoir of considerable extent near its source, which cannot fail to lead to the erection of machinery on many falls that are at present unoccupied.

Of still greater importance, in this respect, is the river Leven, in the county of Fife, which has for its reservoir Lochleven, in the county of Kinross. The *available* supply of water from this lake has, during the last fifteen or twenty years, been very much increased by operations which now enable the mill-owners to *store*, during winter, the surplus water of a very extensive district, and to draw it off in the summer season; by which means, the water-power is equalised, and thus rendered much more valuable than it was before the execution of these works. The average discharge from this lake, ascertained from careful observation, exceeds 6,000 cubic feet per minute.

The surface of Lochleven is about 5,000 acres in extent, is about 370 feet above the level of the sea, and about 14 miles distant from it. Upon this stream many valuable hydraulic engines have been erected, giving profitable employment to a great many of the working-classes. The mode of applying the water-power at Balgonie Mill is novel and interesting, and is the subject of an excellent paper on the Turbine, by Mr. J. G. Stuart, published in Vol. III., Part II., of the Society's Transactions.

The Shaws Water Works at Greenock are interesting, not only in an engineering point of view, but as presenting a most valuable application of water-power to the motion of machinery. These works were planned and executed by the late Mr. Robert Thom. The *quantity* of water, although considerable, is not so great here as is that of the river Leven, to which I have just adverted; but the fall is 510 feet altogether, or 140 feet more than that on the Leven. It differs from the Leven also in this respect, that while the mills on that river are distributed over a distance of 10 or 12 miles, those on the Shaws Water are comprehended in a space little more than a mile and a half in extent, and all of them are within a short distance of the harbour of Greenock.

Much has been done to improve the water-power of the river Bann in Ireland, by the construction of reservoirs, of which there is a detailed description in the Transactions of the Institute of Civil Engineers.

There are other rivers in Scotland—the Water of Leith, for instance—upon which there is a great deal of water-power in operation, not undeserving of notice, and of which I should rejoice to see some account on the table of this Society; but it is of those streams to which I have more particularly adverted, that I am chiefly desirous to obtain accurate and detailed descriptions. It appears to me that well-digested papers, descriptive of the sites and capabilities of the rivers upon which the unoccupied falls of this country, favourably situated for carriage, &c., are to be found, would be valuable acquisitions to this Society, and might, at no distant period, tend to their profitable occupation, and would, if published, not only enrich our Transactions, but render them valuable as books of reference to all who may be in quest of eligible situations for the establishment of public works to which an abundant supply of water is essential.

Drainage and Irrigation.

There are two other branches of hydraulic engineering, which, although we, as Scotchmen, are not so directly interested in them, still possess such general interest, that I may be permitted to advert to them. I refer to the drainage of lakes by steam-power, or of extensive districts by the discharge of water by its outfall, and the judicious distribution of water over sterile soils, by which their fertility is greatly increased.

In the drainage of lakes by steam-power there is a most interesting work now in progress on the coast of Holland. I allude to the Lake (or Mere) of Haarlem; and it is very satisfactory to find that, from the progress already made in this great undertaking, there is every prospect of its being crowned with complete success. The Mere of Haarlem is a fresh-water lake, situated between Leyden and Amsterdam. It is separated from the sea by a narrow strip of land, and communicates with the Zuyder Zee. The bottom of it consists of an alluvial deposit, well suited for agricultural purposes, the cultivation of which, indeed, is the chief object in view in draining the lake. The area of it is upwards of 45,000 acres, being equal to about four-fifths of the area of the county of Kinross. Its form is somewhat irregular; but if square, the side would be nearly nine miles in extent. The average depth is about 13 feet; but it is computed, that, in order to keep the water sufficiently low to admit of crops being raised on what is now the bottom of the lake, it will required to be raised nearly 17 feet. The estimated quantity of water to be pumped is 800,000,000 of gallons, which may be increased to 1,000,000,000. This is, in many respects, a most interesting work, and is an example of agricultural hydraulic engineering much superior to any with which I am acquainted. I hope to have an opportunity of making a personal inspection of this magnificent undertaking in the course of the spring; and if I accomplish this, I shall take care to put this Society in possession of all the information I can procure respecting it.

Of the system of draining by natural outfall, we have several very interesting examples in England, in which the most eminent engineers of the day have been engaged; of these, that of the Great Bedford level, near Lynn, is, perhaps, the most important.

The drainage of the Shannon in Ireland, recently completed at great expense, of which a moiety was defrayed by government, also presents some interesting works of agricultural hydraulic engineering. The reports to parliament, which are to be found in the "*Blue-Books*," contain materials for an account of these works; and I trust that we shall ere long have a concise description of them on our table.

Before closing my observations on hydraulic engineering, permit me to say a few words respecting *irrigation*, a branch of agriculture to which I think sufficient attention has not been paid by our cultivators. In this, Gloucestershire and Wiltshire take the lead in England; and, in Scotland, Dumfriesshire is, I believe, entitled to the first place. The late Sir Charles S. Menteath of Closeburn, long a valuable member of this Society, irrigated very extensively and to profit; and I believe that wherever the principle has been properly carried out, the results have been most satisfactory. It is much to be regretted that such a want of information prevails among many farmers, with regard to the most approved modes of executing the works necessary to the efficiency of this system, and among none

* Continued from page 46.

more than our Scotch farmers. On this branch of agriculture, they have still very much to learn, and many of them, particularly in pastoral districts, could not fail to turn its application to good account. There are numerous streams in many parts of the country, which, if properly directed to the fertilizing of the adjoining land, would tend prodigiously to increase the produce.

MONTHLY NOTES.

Stirling's Patent Toughened Iron.—The satisfactory result of the extensive series of experiments recently made upon this iron, under the superintendence of the authorities of the Admiralty and others, has now directed the attention of practical engineers to the great advantages derivable from the improvement, in securing increased strength with less material. This important property is given to the metal by means as simple as the result is effective—being nothing more than the mingling of fragments of wrought-iron with the east metal as it comes from the blast furnace. The subsequent melting of the iron for use, causes an intimate mixture or permeation of the granular texture of the cast-iron with the fibrous substance of the wrought metal, and the addition of a small proportion of the latter is sufficient to double the strength of the mass—that is, comparing the product with the ordinary cast-iron. Mr. Jee, one of the engineers of the grand Junction Railway, and professionally connected with many other important engineering works, has, after a thorough investigation of the patented iron, adopted the improvement, and undertaken the management of the patent. In Scotland, the introduction of the new metal has been entrusted to Messrs. Johnson of Glasgow, consulting engineers, and vigorous measures are now being adopted for bringing the invention into practical use. The inventor, Mr. Morries Stirling, has also specified, under the same patent, a most important improvement in wrought-iron, which, in its application to railway bars, does not laminate under frictional pressure. The improved wrought-iron is also applicable for numerous other uses, where strength and an anti-laminating property are essentials.

High Farming in 1850.—In our last number we gave a notice of a little work, pointing at high farming, economically conducted, as the remedy for our present agricultural short-comings. We lately had the opportunity of seeing a very fair example of the action of this system on a farm in the extreme north of Lancashire, which is worth the examination of the young, and consequently pliable agriculturist.

The farm in question is "Brackenthwaite," situated about a dozen miles to the north of Lancaster. For centuries back, until within the last few years, this farm had been managed in that true old school fashion, which modern tillers of the soil are so fast repudiating. A few years ago it fell into the hands of its present high-farming proprietor, W. Waithman, Esq., an extensive flax manufacturer in the neighbourhood; and the system he has adopted, would, we are persuaded, please even Mr. Thorold.

The ground, which could not be styled first-rate, as it had a good deal of flat marshy fields about it, has been thoroughly drained, the hedges cut down to shadows, and all the scattered timber remorselessly swept away. In its present condition, whilst it presents little that would find favour in the eyes of a painter, or Dr. Syntax in search of the picturesque, it has many charms for the severe economist, who will see in it every available inch of space turned to account. The old farm buildings, without being totally rebuilt, have been thoroughly remodelled, with very considerable additions, so as to carry out to its very fullest extent the liquid manure-tank system, and the factory-like precision of steam-driven machinery. Despite the apparent unnatural treatment of cattle in stall-feeding, and the painfully ugly hoofs, which long standing without frictional wear produces, the whole of them are in splendid condition, and enjoy tremendous appetites.

The piggery, containing something like 150 animals of all sizes, from the suckling up to the father of generations, would rejoice Mr. Huxtable's heart, with its extent and cleanly arrangement.

A steam-engine, of some 4 or 5 horse power, on the ground floor, serves to drive turnip and straw cutters and dressing machines, whilst its spare steam reduces the great mass of food required for the establishment.

An experiment of this kind requires time for its full development. As a commercial speculation, this appears to have every chance of success even now, whilst every year the improved condition of the land becomes more apparent.

We see, by the *Ayr Advertiser*, that an extensive trial of the same kind is now being made on the farm of Mr. Kennedy, at Myremill, Maybole. There 600 acres are in occupation. One of the chief peculiarities in its management is the system of applying the liquid manure. Tanks, capable of holding 200,000 gallons, are fitted up, and from these, lines of cast-iron pipes are laid down for the supply of 350 acres. In the centres of each field are stop-cocks, one for each ten acres; and when the liquid is to be distributed, gutta percha hose, in lengths of about 30 feet, is attached to these cocks, so that, beginning at the centre, and gradually adding additional piping, the whole field is eventually taken in, the liquid being forced through the pipes by a force-pump, driven by the farm-engine.

Steam Boiler Tubes.—A patent has recently been specified by Mr. Bannister of Birmingham, for the manufacture of locomotive boiler and other tubes, by a combination of three different metals—brass, iron, and copper. Annealed brazed tubes of these three metals are placed one inside the other, the brass being the innermost, the iron in the centre, and the copper outside. Into this triple tube is introduced a slightly tapering mandril, and the three are drawn through a series of dies until they are closely combined. The patentee states, that, by this mode of construction, he secures the good qualities of brass for the surface, where the rush of the flame, and the products of the fire take place—with the stiffening power of the iron, and the advantage of the copper next the water.

The "Three Bells."—We lately observed lying in the harbour, close up to Glasgow Bridge, a beautiful little craft, the elegance of which at once attracted the attention of the passer-by. On examination, she turned out to be the "Three Bells," just built by Messrs. Denny, Brothers, at Dumbarton, for the Messrs. Bell of this city, well known for their maritime enterprise. She is of iron; and it is not giving her too high a character, to say that she is perhaps the most elegant of her class that we have ever seen. She is 648 tons burthen. Length of keel and fore-rake, 163 feet 6 inches. Breadth of beam, 30 feet. Depth of hold, 18 feet 6 inches. She is ship-rigged; and is divided into four water-tight compartments. Although built for the Australian trade, she is to make her first voyage to Montreal, under the able command of Captain Campbell.

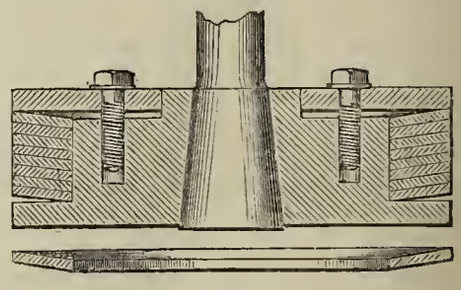
The "City of Glasgow" Screw Steamer.—This fine ship has now departed upon her second outward voyage—having, by her two first trips out and home, definitely settled her position as a first-rate ocean craft. In spite of the very severe weather experienced in going out, she performed her voyage in less time than the Cambria from Liverpool—having done the distance from the Clyde to Sandy Hook in 18 days. Her return trip was made in a fortnight. She has gone out this time as a "full ship," and everything bodes well for the successful establishment of our Glasgow line of Ocean steamers.

The Orion Steamer.—The Orion steamer, which was lost on the 18th, off Portpatrick, was one of the finest sea-going ships hailing from this port. She was built about three years ago by Messrs. Caird of Greenock, and has, we believe, made the quickest passage ever known between Greenock and Liverpool, namely, in a little over 14 hours. She appears to have been running too close in-shore—having struck, when going at full speed, upon the rocks off Portpatrick, and not more than 100 or 150 yards from the shore. Although built of iron in the most substantial manner, and divided into compartments, not more than a quarter of an hour elapsed from the time of striking before she went down in seven fathoms water. The terrible loss of life which has resulted from this most unfortunate affair, has thrown a deep gloom over the city.

Mr. Smith of Deanston.—The newspapers of the day have long since made known the sudden death of this eminent agriculturist and engineer. His health had latterly suffered much from his close attention to his duties as one of the commissioners for inquiring into the means of improving the health of towns—and, latterly, he had arduously devoted himself to sewage improvements, having been engaged as one of the sewage inspectors of the General Board of Health. His was one of the most fertile of inventive minds. Had he lived a few days longer, he would have specified an admirable improvement in treating the fleeces of sheep, as a substitute for the ordinary smearing. Whilst his public character as a man of science stands pre-eminent, those who knew him in private life can attest his many excellencies as a domestic man.

Kennedy's Waterproof Gun Nipple.—This clever contrivance has been considerably improved by a slight modification in the form of the top of the inner nipple. It was found in practice, that loading with a tight wadding had a tendency to cause the powder to issue from the inner nipple. This is now obviated by the formation of a slight internal dished shoulder in the top of the nipple. This shoulder retains the powder, whilst the facility of discharge is not, in the slightest degree, interfered with.

Disc Packing for Pistons and Stuffing Boxes.—A very neat and apparently efficient arrangement of packing has been recently patented by Mr. Gillett of London. As a substitute for the complication of springs and wedges, generally so much relied on, the inventor uses a series of dished metallic discs or rings, which, when used in a piston, are fitted up as represented in the annexed sectional sketch. The detail beneath is a section through one of the disc rings alone. They are made of soft metal, the top and bottom one excepted. As the top plate of the piston is screwed down, it bears upon the upper outer edge of the top disc—tending to force the whole set from a dished to a flat state—thus expanding or enlarging the periphery of the packing as it wears. When perfect flatness ensues, the discs are, of course, worn out, and a new set must be substituted. When applied as stuffing, where the packing must be kept in close contact with a rod, the position of the discs is reversed,—that is, the inner edges embracing the rod are made to point upwards. The pressure of the gland then forces the inner edges downwards, and as their outer edges are confined by the packing chamber, the rod becomes closely encompassed, just as the outer edges are forced up against the cylinder's surface in the piston.



Photography on Glass.—Mr. Malone, in a recent number of the *Athenæum*, furnishes the following contribution to this branch of "light painting:"—"In repeating the experiment of M. Niepce de Saint-Victor on photography on albumen (published in the *Technologiste* for 1848), I was led to devise a plan of my own for making 'glass negatives.' I proceeded as follows:—To the white of an egg its own bulk of water was added; the mixture beaten into a froth was then put into a strainer made of letter-paper, so twisted as to form a cone, having a small aperture at its apex; pinned near the base to hold the paper to its shape. The clear diluted albumen soon passed through into a wide-mouthed bottle, which answered the double purpose of a receptacle for the fluid and a support to the cone. A piece of plate-glass, thick or thin, as you please, was then rubbed with a solution of caustic alkali, washed in water, and dried with a cloth: just before applying the

albumen, the glass was breathed upon and rubbed with new blotting-paper; then, to remove dust and fibres, cotton-wool was used. Unless this latter and every other precaution is taken to prevent dust, the picture will be full of spots, produced by a greater absorption of iodine (in a subsequent process) in those than in the surrounding parts. Now pour the albumen on the glass, inclining the plate from side to side until it is covered; allow the excess to run off at one of the corners, keeping the plate inclined nearly vertical. As soon as the albumen ceases to drop rapidly, breathe on or warm the lower half of the plate; the warmth and moisture of the breath will soon cause it to part with more of its albumen; wiping the edges constantly hastens the operation. Until this plan was adopted, the coatings were seldom uniform; the upper half of the plate retained less albumen than the lower,—of course care must be taken to warm only the lower half. When no more albumen runs down, dry the plate. I use for this purpose a double-ring gas-burner of some eighty jets. A common fire answers as well, save now and then it imparts a little dust. The film, when dry, is quite free from cracks, and is so thin and transparent that the brilliancy of the glass is unimpaired. It is almost necessary to mark it, to know which side has been coated. The next operation is to iodize the plate. Dilute pure iodine with dry white sand in a mortar, using about equal parts of each. Put this mixture into a square glass trough, and over it place the albumined plate; as soon as the latter has become yellow in colour, resembling beautiful stained glass, remove it into a room lighted only by a candle, or through any yellow translucent substance—yellow calico, for instance. Here plunge it vertically and rapidly into a deep narrow vessel containing a solution of 'aceto-nitrate' of silver, made by adding three ounces of nitrate of silver to two ounces of glacial acetic acid, diluted with sixty ounces of distilled water. Allow it to remain until the transparent yellow tint disappears, to be succeeded by a milky-looking film of iodide of silver. Washing with distilled water completes this operation. The plate is now ready for the camera. After it has been submitted to the action of the light, pour over its surface a saturated solution of gallic acid. A negative Talbotype image on albumen is the result. Washing with water before and after immersion, in a solution of one part of hyposulphite of soda in 16 parts of water, until the yellow tint is removed from the shadows, completes the process. But where is the novelty? Let us go back a step. While the gallic acid is developing its reddish-brown image, pour upon the surface a strong solution of nitrate of silver,—the brown image deepens in intensity until it becomes black. Another change commences: the image begins to grow lighter, and, by perfectly natural magic, finishes by converting the black into white, presenting the curious phenomenon of the conversion of a Talbotype *negative* into, apparently, a Daguerreotype *positive*, but by very opposite agency, no mercury being present;—metallic silver (probably) here producing the lights, while in the Daguerreotype it produces the shades of the picture. I have said probably, because it may be unwise to speculate chemically upon appearances which may depend solely on molecular arrangement;—an intricate subject, to which I hope this communication may prove a slight contribution. Prof. Wheatstone has suggested to me the desirableness of substituting blackened wood or blackened ivory for glass plates; we should probably then have the novelty of a Daguerrotype on wood free from some of the disadvantages attendant on polished metal. Mr. Cundall suggests the application of it to wood blocks for wood engravers for certain purposes, making the drawings by light instead of by hand."—[Mr. Cundall has here forestalled us in the publication of what has many times occurred to us—for we some time ago made preparations for testing the very thing which he hints at. There can be little doubt but that, for some pictures, this process may be made exceedingly valuable in the transfer of delineations to the wood.—Ed. P. M. Journal.]

ENGLISH PATENTS.

Sealed from 22d May, to 20th June, 1850.

William Edward Newton, Chancery-lane, civil engineer,—"Improvements in warming and ventilating buildings."—(Communication.)—May 22d.

Robert Cotgreave, Eccleston, Cheshire, farmer,—"Certain improvements in machinery or apparatus to be used in draining land."—22d.

Henry Columbus Hurry, Manchester, civil engineer,—"Certain improvements in the method of lubricating machinery."—22d.

William Palmer, 14 Cottage Grove, Bow-road, Middlesex, gentleman,—"Improvements in the manufacture of candles and candlewick, and in the machinery applicable to such matters."—22d.

Jules Frederick Maillard Dumesk, Paris,—"Certain improvements in reflectors for luminaries."—22d.

Simon Pincoffs, Manchester, merchant,—"Certain improvements in the dyeing process in calico-printing and dyeing, which improvements are also applicable to other processes in calico-printing and dyeing."—23d.

William Radley, chemical engineer, and Frederick Meyer, oil merchant, both of Lambeth, Surrey,—"Improvements in treating fatty, oleaginous, resinous, bituminous, and cerous bodies, in the manufacture and application of them, and of their components and subsidiary products, together with the apparatus to be employed therein, to new and other useful purposes."—25th.

Edward Pettitt, Birmingham, civil engineer,—"Improvements in the manufacture of glass, in the method of forming or shaping and ornamenting vessels and articles of glass, and in the construction of furnaces and annealing kilns."—25th.

John Hickman, Walsall, Stafford, clerk,—"Improvements in the manufacture of cylindrical and other tubes."—25th.

Alfred Vincent Newton, Chancery-lane, mechanical draughtsman,—"Improvements in couplings for carriages, and in the attachment of wheels to axles."—(Being a communication.)—28th.

James Ashworth, Rochdale, Lancaster, manufacturer, and Thomas Mitchell, of the same place, manager,—"Certain improvements in machinery or apparatus for preparing, spinning, and weaving cotton, wool, and other fibrous materials."—29th.

Jonathan Harlow, Birmingham,—"Improvements in the manufacture of bedsteads and other articles for sitting or reclining on."—30th.

Edwyn John Jeffery Dixon, Royal Slate Quarries, Bryntrafood, near Bangor, North Wales,—"Improvements in the manufacture of sinks and other articles of slate or stone."—30th.

Thomas Page, Middle Scotland-yard, Middlesex, civil engineer,—"Improvements in the construction and means of cleansing sewers."—June 1st.

Ezra Jenks Coates, Bread-street, Cheapside, London, merchant,—"Improvements in the manufacture of bolts, spikes, and nails."—1st.

Moses Poole, Patent Bill Office, London, gentleman,—"Improvements in machinery for punching metals, and in the construction of springs for carriages and other uses."—1st.

Arthur Elliott, machine-maker, Manchester, and Henry Heys, of the same place, book-keeper,—"Certain improvements in machinery for manufacturing woven fabrics."—1st.

Guillaume Ferdinand de Douhet, Clermont Ferrand, France, gentleman,—"Improvements in the disoxygenation of certain bodies, and the application, separately or simultaneously, of the products therefrom to various useful purposes."—1st.

Frank Clark Hills and George Hills, Deptford, Kent, manufacturing chemists,—"Certain improvements in manufacturing and refining sugar."—1st.

Samuel Brown, Lambeth, Surrey, engineer,—"Improvements in engines for measuring and registering the flow of fluids and substances in a fluid state, which improvements are also applicable to steam and other motive engines."—1st.

John Tucker, Royal Dockyard, Woolwich, Kent, shipwright,—"Improvements in steam-boilers, and in gearing, cleansing, and propelling vessels."—(Being a communication.)—1st.

George Hayward Ford, St. Martin's-le-Grand, Middlesex, gentleman,—"Improvements in obtaining power."—3d.

Paul d'Angely, Paris, France, gentleman,—"Certain improvements in the construction of privies and urinals, and in apparatus and machinery for cleansing privies, cesspools, and other places, and in deoderizing the matter extracted therefrom, and rendering it available for agricultural purposes."—4th.

David Napier and James Murdock Napier, York-road, Lambeth, Surrey, engineers,—"Invention of improvements in apparatus for separating fluid from other matters."—4th.

Theodore Cartali, Manchester, merchant,—"Certain improvements in the treatment or preparation of yarns, or threads, for weaving."—(A communication.)—4th.

William Watson, the younger, Chapel Allerton, York, manufacturing chemist,—"Improvements in the preparation and manufacture of various materials to be used in the processes of dyeing, printing, and colouring."—4th.

John Sykes and Adam Ogden, both of Dock-street, Huddersfield, York, wool cleaners and machine makers,—"Certain improvements in machinery for cleaning wool, cotton, and similar fibrous substances from burrs, motes, and other extraneous matter."—4th.

Edmund Sharpe, Lancaster, architect,—"Certain improvements in railway carriages."—5th.

William Edward Newton, Chancery-lane, civil engineer,—"Improvements applicable to boots, shoes, and other coverings for, or appliances to, the feet."—(A communication.)—6th.

George Jackson, Belfast, Ireland, flax-spinner,—"Improvements in heckling machinery."—6th.

John M'Nicoll, Liverpool, engineer,—"Improvements in machinery for raising and conveying weights."—6th.

William Robertson, Gateside-hill, Neilston, Renfrew, Scotland, machine maker,—"Improvements in certain machinery used for spinning and doubling cotton and other fibrous substances."—6th.

James Alexander Hamilton Bell, New York, America, merchant,—"Improvements in dressing bran, pollard, and sharps."—(A communication.)—6th.

A grant unto William George Bicknell, Essex-street, Strand, and James Reginald Torin Graham, Grove, Clapham-common, of an extension for the term of six years of letters patent granted by his late Majesty King William IV. to Miles Berry, Chancery-lane, patent agent,—"For an invention of certain improvements in machinery or apparatus for cleaning, purifying, and drying wheat or other grain or seeds."—7th.

William Newton, Chancery-lane, civil engineer,—"Certain improvements in the manufacture of cords, ropes, bands, strong cloths, quilting, sacks, and cushions, and in elastic material for stuffing the latter, in which manufacture caoutchouc forms an essential ingredient, and in the application of parts of these improvements to the manufacture of pads, stoppers, tubes, boxes, baskets, coverings, wrappers, and other like articles of utility."—(Being a communication.)—8th.

James Colman, Stoke Mills, Stoke, near Norwich, Norfolk, mustard and starch manufacturer,—"Improvements in the manufacture of starch."—8th.

Pierre Armaud Lecomte de Fontainemoreau, South-street, Finsbury, London,—"Certain improvements in oscillating engines put in motion by steam, and gas resulting from combustion."—(Being a communication.)—8th.

Charles Warwick, Cheapside, warehouseman,—"Improvements in apparatus for taking up the work of certain descriptions of knitting machinery."—(A communication.)—8th.

Pierre Armand Lecomte de Fontainemoreau, South-street, Finsbury, London,—"Certain improvements in the manufacture of sulphate of soda, muriatic and nitric acids."—(Being a communication.)—11th.

William Edward Newton, Chancery-lane, civil engineer,—"Improvements in machinery for carding cotton, wool, or other fibrous materials, and in apparatus for preparing or setting the cards of carding-engines."—(Being a communication.)—11th.

William Jackson, Kingston-upon-Hull, soapmaker,—"Improvements in the manufacture of soap, and in the preparation of materials to be used for that purpose."—11th.

William Edward Newton, Chancery-lane, civil engineer,—"Improvements in rotary engines."—(Being a communication.)—11th.

Robert Waddell, Liverpool, Lancaster, engineer,—"Certain improvements in steam-engines."—11th.

Alexander Parkes, Pembrey, Carmarthenshire, experimental chemist,—"Improvements in smelting and treating certain metals, and in the construction and manufacture of furnaces, and the materials to be used for the same, such furnaces and materials being applicable to the treatment of metals and metallic compounds, and to various other useful purposes of a like nature."—11th.

William Pole, Great George-street, Westminster, engineer, and David Thomson, Belgrave-road, Pimlico, engineer,—"Improvements in steam-engines."—11th.

John Henry Vries, Norfolk-street, Strand, Middlesex, Esq.,—"Improvements in working engines by atmospheric air."—11th.

James Palmer Budd, Ystalyfera Iron Works, Swansea, merchant,—"Improvements in the manufacture of coke."—11th.

John Dearman Dunnicliff, Hyson Green, Nottingham, lace manufacturer, and John Woodhouse Bagley, Radford, in the said county, lace-maker,—"Certain improvements in lace and other weavings."—11th.

Samuel Ellis, Salford, engineer,—"Improvements in machinery or apparatus applicable to all kinds of carriages used on railways."—11th.

Frederick Albert Gatty, Accrington, Lancaster, manufacturing chemist,—"A certain process, or certain processes, for obtaining carbonate of soda and carbonate of potash."—11th.

William Cox, of the firm of William Cox & Co., Manchester, cigar merchant,—"Certain improvements in machinery or apparatus for manufacturing aerated waters or other such liquids."—11th.

John Sidebottom, Broadbottom, Chester, manufacturer,—"Improvements in looms for weaving."—11th.

William Mac Lardy, Manchester, machinist,—"Certain improvements in machinery or apparatus for preparing, and finishing, and doubling cotton, and other fibrous materials."—12th.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in the production of gases to be used for lighting, heating, and motive power purposes."—(Being a communication.)—12th.

Gustavus Palmer Harding, Bartlett's-buildings, London, artificial florist,—"Improvements in the manufacture of buttons and other fastenings."—12th.

Thomas Deakin, Balsall Heath, Worcester, Esq.,—"Certain improvements in machinery and apparatus to be used in rolling metals, and in the manufacture of metal tubes."—12th.

John Stopporton, Isle of Man, engineer,—"Certain improvements in propelling vessels."—12th.

William Edward Newton, Chancery-lane, civil engineer,—"Certain improvements in the construction of railways."—(Being a communication.)—12th.

George Allen Everitt, of the firm of Allen, Everitt, & Son, Kingston Metal Works, Birmingham, metal and tube manufacturers, and George Glydon, Birmingham aforesaid, engineer and foreman to the said Allen, Everitt, & Son,—"Certain improvements in the manufacture of metal tubes for locomotive, marine, and other boilers."—12th.

John Manly, jun., Birmingham, manufacturer,—"Certain improvements in the manufacture of nails."—12th.

Charles Lamport, Wortrington, Cumberland, shipbuilder,—"Certain improvements in machinery or apparatus for lifting and moving weights, working chains, and pumping, which improvements are more especially adapted to ship use."—19th.

Charles Greenway, Green-street, Grosvenor-square, Middlesex,—"Improvements in ships' and other pumps, in anchors, and in propelling vessels."—19th.

Benjamin Cheverton, Camden-street, Camden-town, Middlesex, artist,—"Methods of imitating ivory and bone."—19th.

Charles Hanson, Stepney, Middlesex, engineer,—"Certain improvements in steam-engines, steam-boilers, and safety-valves, and in apparatus and machinery for propelling vessels."—19th.

Isaac Hartas, Wretton Hall, York, farmer,—"Improvements in machinery for obtaining motive power."—(Being a communication.)—19th.

Robert Heath, Manchester, iron merchant, and Richard Hendley Thomas, Woolstanton, Stafford, engineer,—"Certain improvements in the manufacture of iron."—19th.

Ethan Baldwin, Philadelphia, Pennsylvania, United States of America,—"A new and useful method of generating and applying steam in propelling vessels, locomotives, and stationary machinery."—19th.

Robert Weare, Angel-court, Throgmorton-street, clock and watch manufacturer,—"Certain improvements in the means and apparatus for extinguishing fire, and in galvanic batteries."—19th.

George Robarts, Tavistock, Devon, gentleman,—"Certain improvements in clogs and pattens."—19th.

Gaspard Malo, Dunkirk, France, shipowner,—"Certain improvements in propelling vessels."—20th.

William Saunders, of the firm of Randell and Saunders, Bath, Somerset, stone merchants,—"Improvements in sawing and sawing machinery."—20th.

John Hunt, Stratford, Essex, engineer,—"Improvements in forming and moulding plastic substances, and the machinery and apparatus employed therein."—20th.

SCOTCH PATENTS.

Registered from 22d May, 1850, to 22d June, 1850.

George Jackson, Belfast, flax-dresser,—"Improvements in heckling machinery."—May 24th.

Frederick Rosenborg, Albemarle-street, Middlesex, Esq.; and Conrad Montgomery, army and navy club, St. James'-square, same county, Esq.,—"Improvements in sawing, cutting, boring, and shaping wood."—24th.

George Hayward Ford, St. Martin's Le Grand, Middlesex,—"Improvements in obtaining power."—27th.

Joseph Barrans, St. Paul's, Deptford, Kent, engineer,—"Improvements in axles and axleboxes of locomotive engines and other railway carriages."—27th.

Samuel Fisher, Birmingham, Warwickshire, engineer,—"Improvements in railway carriage-wheels, axles, buffer, and draw springs and hinges for railway-carriage and other doors."—28th.

Thomas Chandler, Stockton, Wilts,—"Improvements in machinery for applying liquid manure."—28th.

Thomas Dickson Rotch, Drumlamford House, Ayrshire, Esq.,—"Improvements in separating various matters, usually found combined in certain saccharine, saline, and ligneous substances."—(Communication.)—28th.

Henry Columbus Hurry, Manchester, Lancashire, civil engineer,—"Certain improvements in the method of lubricating machinery."—29th.

Simon Pincoffs, Manchester, Lancashire, merchant,—"Certain improvements in the dyeing process, in printing and dyeing calicoes and other woven fabrics, which improvements are also applicable to other processes in printing and dyeing calicoes, and other woven fabrics."—30th.

James Palmer Budd, of the Ysaltyfera Iron Works, Swansea, merchant,—"Improvements in the manufacture of coke."—31st.

William Macalpine, Spring Vale, Hammersmith, Middlesex, general draper, and Thomas Macalpine, of the same place, manager,—"Improvements in machinery for washing cotton, linen, and other fabrics."—31st.

Charles Andrew, Compstall Bridge, Cheshire, and Richard Markland, of the same place, manager,—"Certain improvements in the method of, or apparatus for, preparing warps for weaving."—31st.

John Dalton, Hollingworth, Chester, calico printer,—"Certain improvements in, and applicable to machinery or apparatus for bleaching, dyeing, printing, and finishing textile and other fabrics, and in the engraving of copper rollers, and other metallic bodies."—June 5th.

Frederick Albert Gatty, Accrington, Lancashire, manufacturing chemist,—"A certain process, or certain processes for obtaining carbonate of soda, and carbonate of potash."—5th.

Jules Le Bastier, Paris, but now of South-street, Finshury, Middlesex, gentleman,—"Certain improvements in machinery or apparatus for printing."—6th.

William Robertson, Gateside Mill, Neilston, Renfrewshire, machine maker,—"Improvements in certain machinery used for spinning and doubling cotton, and other fibrous substances."—7th.

Francis Tongue Rufford, Prescott House, Worcester, fire-brick manufacturer, and Isaac Mason, Cradley, in the same county, potter, and John Finch, Pickard-street, City Road, Middlesex, manufacturer,—"Improvements in the manufacture of baths and wash-tubs, or wash-vessels."—10th.

Baron Louis Lo Prasti, Paris, France,—"Improvements in hydraulic presses, which are, in whole or in part, applicable to pumps and other like machines."—10th.

Arthur Elliot, machine maker, Manchester, Lancashire, and Henry Heys, of the same place, book-keeper,—"Certain improvements in machinery for manufacturing woven fabrics."—14th.

Charles Cowper, Southampton Buildings, Chancery-lane, Middlesex, patent agent,—"Improvements in instruments for measuring, indicating, and regulating the pressure of air, steam, and other fluids, and in instruments for measuring, indicating, and regulating the temperature of the same, and in instruments for obtaining motive power from same."—(Communication.)—14th.

William Watson the Younger, Chapel Allerton, parish of Leeds, Yorkshire, manufacturing chemist,—"Improvements in the preparation and manufacture of various materials to be used in the processes of dyeing, printing, and colouring."—18th.

William Edward Newton, of the Office for Patents, 66 Chancery-lane, Middlesex, civil engineer,—"Improvements in rotary engines."—(Communication.)—21st.

James Ward Hoby, Blackheath, Kent, engineer,—"Certain improvements in the construction of parts of the permanent way of railways, and in shaping iron."—21st.

IRISH PATENTS.

Sealed from 21st May, 1850, to 19th June, 1850.

John Stevenson, Roan Mills, Dungannon, Tyrone, flax spinner,—"Certain improvements in machinery for spinning flax, and other substances."—25th May.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 16th May, to 16th June, 1850.

May 16th, No.	2303.	W. Baddeley, Alfred-street, Islington,—"Portable fire-engine."
—	2304.	Capper and Waters, Regent-street,—"Combined jacket and shirt."
23d,	2305.	James Nasmyth, Patricroft, Lancashire,—"Framing for a portable steam-engine."
24th,	2306.	John Sutton, Stamford-street, Blackfriars-road,—"Adjustable inkstand."
—	2307.	J. Harrison, John-street, Fitzroy-square,—"Boudoir pianoforte action."
25th,	2308.	William Brodie, Airdrie,—"Tile machine."
—	2309.	Marmaduke Osborn Bergin, Cork,—"Automatic fire-extinguisher."
—	2310.	Alfred Bird, Birmingham,—"Filter."
27th,	2311.	John Davenport, Sheffield,—"Graining comb."
29th,	2312.	William Wright, Kilworth Co., Cork,—"Mill-stone furrows and feeder."
—	2313.	Allan Livingston and Son, Portobello, near Edinburgh,—"Hermetical cradle for joining pipes suitable for water sewerage."
30th,	2314.	Francis West, Fleet-street and Strand,—"Radius rule."
—	2315.	William Pope and Son, Edgeware-road,—"Stop-valves for the admission of hot and cold water for bath and wash-house purposes."
—	2316.	John Roe, West Bromwich,—"Lock."
31st,	2317.	John Marvin, London Gas Works, Vauxhall,—"Portable smelting apparatus."
—	2318.	John Heather, Bedford-court, Covent-garden,—"Blackwell's razor-guard."
—	2319.	Emanuel Bailey Mather, Oxford-road, Manchester,—"Drag with moveable body."
—	2320.	Joseph Fenn, Newgate-street,—"Cymameter."
June 3d,	2321.	William Peter Pigott, Oxford-street,—"Galvanic belt."
—	2322.	John Hill, Jermyn-street,—"The Choretikopas, a portmanteau on a new construction."
4th,	2323.	William John Normanville, Queen's-road, Regent's Park,—"Elastic attachment for the side chains of railway carriages, wagons, &c."
—	2324.	George Godsell, Regent-street,—"Jupon chemise."
—	2325.	George Ingram, West Bank, Portobello,—"Socket-joint for street and other drains."
5th,	2326.	John Bessell, 7, Farringdon-street, London,—"The invisible ventilator."
—	2327.	Robert Calvert, M.D., Camden-street North, Camden New Town,—"Self-adjusting brace."
6th,	2328.	John Rowan and Sons, York-street Foundry, Belfast,—"Factory ventilators."
8th,	2329.	George Frederic Hipkins, Birmingham,—"The Sportman's Companion," combining nipple-wrench, turnscrew, nipple-pricker, wafer-stamp, and corkscrew.
10th,	2330.	C. A. and T. Ferguson, Millwall,—"Gun carriage."
—	2331.	Edwin Greenslade Bradford, Teignmouth, Devon, jeweller,—"Fastener for garments."
—	2332.	John Edward Smith, Lawrence-lane, Cheapside,—"Shirt."
—	2333.	Thomas Grubb, Dublin, civil engineer,—"Spindle and bearing for the dashers of revolving dasher churns."
11th,	2334.	James William Giles, Aldersgate-street,—"Dress pin."
13th,	2335.	George Baddeley, 521 Oxford-street,—"Boot."
—	2336.	William Pilbeam, Acton-street, Gray's-inn-road,—"Smoke-preventing chimney pot."
14th,	2337.	Richard Robinson, the Eliza-street Works, Belfast,—"Compound bar furnace."
—	2338.	Charles Burton, Trowbridge,—"Elastic mauler for a weaver's harness."
17th,	2339.	William Bird, Oxford-street,—"Boot."
—	2340.	Frederick and Charles Huxham, and James Armitage Brown, Exeter, Devonshire,—"Driving motion for hand-mills."
—	2341.	Ann Remington, Shaftesbury-crescent, Pimlico,—"Self-acting baster and vertical heat reflector for roasting."
—	2342.	Taylor, Henry, and Co., White Lion-street, Spittle-square,—"Imperial disinfecting filter."
20th,	2343.	Philip Le Capelain, the Elder, Long Acre,—"Portable oven."

TO READERS AND CORRESPONDENTS.

T. P., Hants.—The well-known "Queen of Beauty" of the Clyde, is an example of the utter failure of a trial of his plan on an extensive scale. The arrangement, however, differed from that of our correspondent, in the fact, that the propelling surfaces were simply attached to a single endless chain passing over two pulleys, so that each board propelled in one direction and returned in the other. His scheme, although more complex, appears to give the propellers a better effect upon the water. The mode of carrying them is very ingenious, but we could not recommend the plan for trial.

Hackworth's Locomotive.—We have to beg the indulgence of our readers for the non-appearance of the concluding plate of this engine in the present part. We have substituted "Sims' Horizontal Double-Action Engine" for it.

Iron.—The use of the cone is so obvious, that we cannot take up any space here by explaining it. Although it involves, to a certain extent, the introduction of one evil for the removal of another, it is yet the best remedy for overcoming a practical difficulty which we possess. Read any elementary work on railways.

Received.—*Description of Harbour Screw-Cramps.*

A Working Mechanic, Newcastle.—We shall take care to supply his want next month.

J. R., Ardrossan.—As we shall probably have something to say on the subject of the inquiry next month, his memorandum will be attended to.

STIRLING'S TOUGHENED CAST-IRON.

One of the most recent of the practical novelties connected with the iron manufacture, is the system of toughening and strengthening the metal patented hy Mr. Morries Stirling, whose late researches have opened up several new features in this most important hranch of our staple productions. We say *practical* novelties, to distinguish the invention from the great mass of mere schemes which melt away to nothingness on the first working test—bringing discredit on their propounder, and disgusting the practical man who is tricked into a trial of their capabilities. That Mr. Stirling's improvement does not helie its name, has heen satisfactorily established by its fast extending introduction in constructive engineering, and the uniform good opinion which has been expressed upon it by the first engineers of the day.

The process is so extremely simple in practice, that it hardly deserves the name. All that is done, is the placing pieces of wrought or scrap iron in the moulds used in forming the pigs of metal run from the blast furnace; the melted cast-iron surrounds the solid scraps, and the incorporated mass hecomes what, in the "prices current of metals," is termed "Stirling's patent toughened pig." In this state the iron is sold to the consumer, and when remelted in the founder's cupola for use, the mixture enters into chemical combination, producing, as the inventor remarks in his evidence bcfore the commissioners appointed to inquire into the application of iron to railway structures, "to a certain extent, a diminution of the quantity of contained carbon, an alteration in the structure, and a differently formed grain."

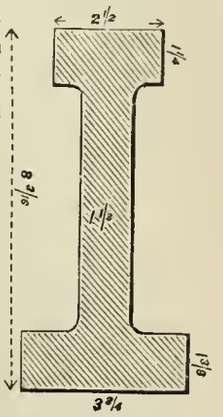
Cast-iron, so compounded, hecomes close in the grain, and without any injury to its fusihility, has imparted to it an extraordinary toughness. In this way, whilst the great facilities of application of cast-iron are fully retained in the toughened metal, many of the excellencies of malleable-iron are given to it, making it, for all purposes where strength and lightness are essentials, a most valuahle material for the railway engineer and the builder, and for many of the purposes of the general iron-founder. The strength of the iron, of course, varies with the proportions of the added wrought metal—the average superiority over ordinary cast-iron being from 60 to 70 per cent., whilst the maximum increase has been experimentally demonstrated to he 120 per cent.

In commencing his cxperiments, Mr. Stirling's idea was simply to improve or elevate the standard of the inferior irons—that is, to bring up the strength of the weaker and more fluid irons to an equality with the hetter kinds; hut in working out these experiments, the remarkable fact came out, that all classes of iron are, hy this admixture, hrought to a general average strength, far exceeding that of the best east-iron. Taking Mr. Hodgkinson's results, we find that to hreak a bar of Blaenavon iron, 1 inch square, and 4 feet 6 inches hetween the supports, requires an average of only 454 lhs.; the highest result being 578 lhs. In Mr. Stirling's own experiments with his toughened iron, the hreaking weight of 868 lbs. has heen reached; whilst Mr. Rennie, using Mr. Stirling's method, obtained more than 900 lbs.; the average may he taken at about 750 lhs.

The proportions of wrought and cast-iron depend both upon the locality furnishing the iron, and upon the number or quality-mark of the maker. As a general rule, the Scotch iron requires the greatest amount of scrap; the Welsh the least; whilst the Staffordshire iron is hetween the two. For Scotch, No. 1, hot-hlast, from 24 to 40 lhs. of scrap must he added to the cwt., according to the richness of the iron; No. 2 requires less—from 20 to 30 lhs.; whilst for general purposes, No. 3, hot-hlast, is not recommended for mixture, except for large castings, for which 15 or 20 per cent. of scrap produces an admirable iron. Each of the qualities of Staffordshire and Welsh iron requires considerably less than these amounts.

One of the first inquiries to he made in reference to the commercial introduction of any improvement, relates to its cost. In the case before us, there is no increase in the cost of the iron, except in relation to the original quality of the metal from which it is made. Thus, Scotch pig-iron at £2. 10s., when the expense of the malleable-iron and the patentee's royalty is added to it, costs from 10s. to 15s. per ton extra; but as a set-off, the iron so made is 60 per cent. stronger than iron which commands a price of £3. 15s. and £4 per ton. The improvement on the best iron is not so palpahle as on the worst qualities, although Mr. Rennie's experiments show that the best or Blaenavon iron is improved as much as 67 per cent. In fact, the whole of the experimental tests go to show that the mixture tends to bring up all iron to its maximum strength; and whichever of the three kinds of iron is taken, a proper proportion of scrap ought to give it an average of 700 or 800 lbs. on the square inch.

The annexed sketch exhibits a transverse section of a cast-iron beam, used in testing the strength of the toughened iron when applied for this purpose. Two heams of each kind of metal were cast from the same pattern hy Messrs. Grissell, the experiment being conducted at the new Palace of Westminster, under the superintendence of Mr. Barry. The ordinary castings were a compound of hot-blast, Scotch, Blaenavon, and old iron, in equal parts; whilst the toughened metal was made up of 89 lbs. of Kinneil iron to 23 lbs. of scrap. The heams were of the same section throughout their entire length—12 feet 4 inches—the hearing distance heing 11 feet. The power was applied by a Bramah press, in the centre of the heams; and the hreaking weight of the ordinary heams was found to be 15.93 tons, with a deflection of $\frac{15}{16}$ths inch. The toughened heams hroke with 22.5 tons, with a deflection of 1 inch. In testing the permanent set of the beams, the ordinary heam acquired a set of $\frac{1}{8}$th inch, with a pressure of 14.06 tons; but the toughened beam had a set of only $\frac{1}{16}$th inch, with 16.87 tons.



The valuahle report of the commissioners on the application of iron to railway structures, which we have previously quoted, shows that the new iron has been deemed sufficiently important to require a long and careful investigation along with the various specimens selected for experiment in the course of this extensive inquiry. In the trials of tensile strength, the second quality required 11.502 tons per square inch of section to break it; the highest result from Blaenavon being 7.466 tons. The average crushing strength of the second and third qualities was 54 and 64 tons respectively—Blaenavon, No. 2, 49 tons. The mixture for trying the transverse strength was No. 1, hot-hlast, Staffordshire, from Ley's works, with 15 per cent. of malleable-iron, forming toughened metal of the third quality. The dimensions of the bars were:—Length, 10 feet $\frac{17}{120}$ inch; weight, 119 lhs.; weight between supports, 106.97 lbs.; depth, 2 inches; breadth, 1.97 inches. The mean results, with a weight of 1,344 lbs., gave a deflection of 1.939 inches, with a set of .223 inch. The mean breaking weight was 1,470 lbs., with an ultimate deflection of 2.178 inches. To compare such results with those of other kinds of iron, would obviously lead to considerable detail; but the practical worker in iron will be ahle to make his comparisons with the results of his own experience.

All engincers are agreed on the point of the superior strength derived from a mixture of various kinds of iron, and Mr. Fairbairn, in his evidence before the commission, cites Mr. Stirling's improvement as a very decided step in advance of all previous combinations, giving examples of the tests of girders, where the compound iron, compared with ordinary metal, was as 33.25 to 51.5.

Several of the most eminent iron-masters in Scotland are licensees of the invention, and at the Dundyvan works a very extensive series of experiments has been tried upon various compounds of the Dundyvan iron. The mean breaking weight of the ordinary Dundyvan cast-iron—in bars 1 inch square, 2 feet 3 inches between supports—has been ex-

perimentally ascertained to be, No. 1, 860; No. 2, 926; and No. 3, 892. The same iron, No. 1, with 32 lbs. of scrap to the cwt., required 1,434 lbs. to break it; and No. 2, with 29 lbs. of scrap to the cwt., gave a result of 1,419 lbs. The great difference in the texture between malleable and cast-iron, and the observed behaviour of the former under intense heat, has all along led us to believe that any attempt at so curious a combination would result in a mere partial mechanical mixture; and, until Mr. Stirling actually showed that wrought-iron does fuse and combine chemically with cast-iron, the idea was utterly scouted. The combination is, however, perfect, and complete homogeneity is always secured when proper precautions are taken in mixing.

The iron is now being introduced in several large engineering works, for girders, beams, shafts, and rolls; and the Corrugated Iron-Wheel Company have, in several cases, specified it in their arrangements with contractors. Another branch of the invention provides for the strengthening of wrought-iron, and the prevention of lamination under rolling pressure, as in railway bars. For this purpose, either common or toughened pig metal is alloyed with calamine in the puddling furnace. Another process comprehends the addition of a small quantity of tin to the iron in the puddling furnace. The metal thus treated is found to be very hard, crystalline, and anti-laminating. This iron is used for the surfaces of rails and wheel tires, by rolling it along with a greater bulk of the calamine iron.

As the practical results of the introduction of this toughened metal become developed, we shall follow up the subject with additional details.

A FIRST CHAPTER IN MECHANICS.

By D. O. J. Brock, Professor of Mathematics in the Royal University of Christiania.

Every particle of matter with which we are acquainted, is subject, at every instant of time, to the action of several forces. When such forces are in equilibrium, that is, when they balance or neutralize each other, rest is the result; when such forces are not in equilibrium, motion is the result.

Force is usually defined as the cause of motion, but it is equally the cause of rest, there being no instance of rest which cannot be traced to the action of at least two forces.

There is no instance of absolute rest to be found throughout the material world; every particle of matter is ceaselessly undergoing a change of its position in space. Rest is, therefore, only a relative term, used to express the condition of a particle which is undergoing no change of place with respect to other particles comprised in a given portion of space.

Examples of the forces which most frequently destroy the equilibrium of other forces, and thereby induce motion, are afforded by muscular energy, the attraction of the earth or gravitation, heat considered as the expander and evaporator of bodies, magnetism, &c.

It will, however, simplify the questions we shall have to consider, if we assume that, during the time a body is at rest, it is free from the influence of all forces whatsoever, and that, when it quits that state of rest, no other forces than those which induce motion are acting upon it.

When a single force is applied to a particle at rest, that particle receives a tendency to describe a right line, which is termed the direction of the force.

Simple motion is the result of a single force; compound motion of several forces.

The single force which would produce the same effect as, and which consequently can be substituted for, several forces, is termed the resultant of those forces.

When a force is brought to bear upon a particle on the surface of a rigid body, an impression is made which drives that particle against the adjacent particles—those against the particles which are adjacent to them, and so on, until the extremity of the body is reached. If that extremity has a firm support, then the force will occasion a compression and alteration in the form of the body. If, on the other hand, that extremity be at liberty and unsupported, it will move onwards, and the motion is, of course, gradually communicated to the whole body. This occupies time—a short time it may be,—but it is impossible that any degree of velocity can be instantaneously communicated to a body consisting of several particles.

The same thing occurs when a force is employed in putting an end to motion. Motion is first stopped in the particles adjacent to the point of application, and then gradually in those which are more distant, the process requiring time for its completion.

We have supposed the force to be applied to the exterior of the body, and the impression to be communicated thence to the interior. But it acts also from the interior to the surface; if it contracts or expands the body, the particles are driven away from, instead of being brought nearer to, each other, and the next particles, by virtue of the attraction of cohesion existing amongst them, will then endeavour to occupy the same distance from those to which they are contiguous as they did before, and, consequently, will draw to them the other extremity of the body, if it is at liberty. For the communication of this force, a certain time is also required.

Bodies must therefore be considered as composed of molecules, kept at certain distances from each other, by virtue of the molecular force, which is seen as an attracting force when the distance between the molecules is enlarged, and as a repulsive force when such distance is diminished.

A force cannot, then, operate upon a body without occasioning a reaction in the molecular forces of such body; and this reaction, when the body remains at rest, is always equal and opposite to the action. When the force does not operate directly—as, for instance, when it operates through the medium of a rope or bar—the force is communicated by a series of actions and reactions from one end of the rope or bar to the other, and then to the body.

The motion of a material particle is termed uniform, when the particle travels over equal spaces in equal times. When the motion is not uniform, it is called variable; and when the spaces travelled over are continually greater, in equal times, the motion is termed accelerated; and when continually less, retarded. By the velocity of a body is meant the rate at which it moves, and it is found by comparing the space passed over with the time occupied.

A force may be represented by a right line drawn in the direction of the force, and of a length proportional to its magnitude.

Experience has taught us, that the four following laws govern the connection of a force with the motion thereby induced, and the whole science of mechanics is founded upon them.

I. A body at rest cannot begin to move, nor can a moving body change either the direction or the quantity of its motion, or assume a state of rest, except one or more forces operate upon it. This is termed the *law of inertia.*

The resistance with which the inertia of bodies opposes every alteration of their existing condition, whether of rest or motion, will be adverse to the motion of a body when that motion is an accelerated one, and will be favourable to the motion when it is a retarded motion.

II. There exists a similar ratio between the velocities communicated by several invariable forces to the same body in equal times, as exists between the forces themselves; and, in like manner, are related one increase to another increase, and one decrease to another decrease of velocity, when such increases and decreases are respectively produced in the velocity of the same body, by several forces operating in the direction of an existing motion.

Thus, if, in a given time, the force, F, is able to communicate to a body the increased velocity, D V, and the force, f, operating in an equal space of time, is able to communicate to the same body the increased velocity, dv, then

$$\mathrm{F} : f :: \mathrm{D\,V} : dv.$$

This is termed the law of the proportionality of forces, and variations of velocities.

III. In order to produce in different bodies a similar alteration of their velocities, at the same place on the earth's surface, the forces must be proportional to the weights of the bodies.

Thus, if, in a given time, the force, F, communicates to a body, the weight of which is P, a given increase or decrease of the velocity in the direction of the existing force, and in the same time the force, k, communicates to another body of the weight, p, a similar increase or decrease of velocity, then

$$\mathrm{K} : k :: \mathrm{P} : p.$$

If the increase of the velocity is a unity of space in a unity of time, the required force, assumed as operating in the direction of the motion, is termed the mass of the body. The masses of two bodies, being represented by M and m, and the additional velocity which each of two forces, K and k, communicate to the bodies, P and p, in a unity of time, D V, we have the two laws.

$$\mathrm{K} : \mathrm{M} :: \mathrm{DV} : 1$$
$$k : m :: \mathrm{DV} : 1;$$

consequently, $\mathrm{K} : k :: \mathrm{M} : m.$

Now, since $\mathrm{K} : k :: \mathrm{P} : p,$

it follows that $\mathrm{M} : m :: \mathrm{P} : p.$

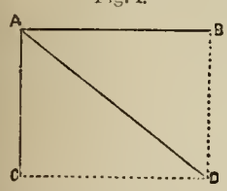
This third law is, therefore, termed the law of the proportionality of the masses, and of the weights of bodies.

IV. When a force acts upon a body already in motion, the change of motion thereby produced is, in magnitude and direction, the same as if the force acted upon the body at rest.

This is termed the law of the independence of the original motion, and the direction of the force. It may be reduced to this general fact, that every motion, common to all the bodies of a given system, does not change the particular motions of those bodies relative to each other; they will make such particular motions as if the whole system were immoveable. Take, for an example, a ball set in motion upon the deck of a vessel moving equably through the water; the ball will move along the deck as it would if the vessel were at rest.

This law leads immediately to what is commonly called the parallelogram of forces, which may be thus explained:—Let us suppose a material particle to be moving, so that, in each unity of time, it travels over a part of its course, the direction and magnitude of which is represented by the line, A B (fig. 1) and that, at the instant when it arrives at A, a force is made to operate upon it, which, had it been at rest, would impel it in a unity of time to C. Now, this force will impel it to D, B D being equal to and parallel with A C; consequently, the particle will move in the direction of the diagonal, A D, as if it were influenced by a single force operating in that direction, which force bears the same relation to the forces which operate in the directions A B and A C, as the line A D bears to A D and A C.

Fig. 1.



By virtue of the second law of the proportionality of forces, and the variations of velocities, forces may be compared with one another by comparing the velocities, which such forces can communicate to a body in a given space of time, with that velocity which gravity is capable of communicating to the same body in the same space of time. The forces will, therefore, be denoted by a statement of the weight of that body to which they are able to communicate the same velocity as gravity.

By P we denote the weight of a body, by g the velocity which gravity communicates to a body in one second of time. By M the mass of the body, that is to say, a force which can communicate to the body the velocity 1, in one second. Therefore, by virtue of the second law,

$$P : M :: g : 1;$$

$$\text{consequently, } M = \frac{P}{g}, \quad g = \frac{P}{M}.$$

This relation, $\frac{P}{M}$, is, in consequence of the third law, the same for all bodies at the same part of the earth's surface; and therefore, g, or the velocity with which a free body in free space has travelled at the end of a second, is the same for all bodies at the same part of the earth's surface. Its value, at different places, may be expressed with great accuracy by the formula,

$$g = 31.9287\ (1 - 0.0025911, \cos. 2\varphi) \text{ Eng. feet,}$$

where φ denotes the latitude of the place. This formula, however, will give the truth only approximatively, because gravity in the same parallel is not everywhere precisely the same.

It follows, from the four grand laws of mechanics, that, if two forces operate upon a material particle, by one of which it would have been driven, in a given time, and in the absence of the other, from A to B, (fig. 1,) and by the second of which it would have been driven, in the same time, and in the absence of the former, from A to C, the particle will, when both forces are applied to it at the same time, move from A to D, along the diagonal of the parallelogram formed by the lines A B and A C.

Let the two forces be represented by X and Y, the angle B A C, which they form, by φ, and let R represent a force which, operating in the direction A D, would have driven the particle from A to D, in the same time in which it was driven by X to B, or by Y to C, then is R the *resultant* of the forces, X and Y; and, by virtue of the second law of mechanics,

$$X : A B :: Y : A C :: R : A D.$$

$$\text{But } A D^2 = A B^2 + B D^2 + 2\ A B, B D, \cos. \varphi;$$

$$\text{consequently, } R^2 = X^2 + Y^2 + 2\ X Y, \cos. \varphi.$$

If the angle $\varphi = 0$, that is, if the forces operate in the same direction, then $R = X + Y$. If $\varphi = 180°$, that is, if the forces are directly opposed to each other, then $R = X - Y$. If $\varphi = 90°$, and, consequently, if the two forces operate in directions at right angles to each other, then $R = \sqrt{X^2 + Y^2}$; and if we represent the angles B A D and C A D by α and β, then

$$X = R \cos. \alpha, \quad Y = R \cos. \beta.$$

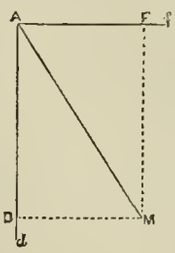
The forces X and Y are termed the *components* of the force along the lines A B and A C. If X and Y are at right angles to each other, they are also termed the projections of R.

When several forces are applied to a particle, we can, in the first place, take any two of them and discover their resultant, in the manner before described, and then go through the same process with that resultant and a third force, and so to the last.

When three forces, applied to a point in space, are not situated in the same plane, their resultant is represented by the diagonal of the *parallelipedon* constructed on the lines which represent these forces in magnitude and direction. By the successive construction of parallelipeds, or even of parallelograms, we obtain the result of any number of forces applied in space to the same point; and, reciprocally, a force is always resolvable into three others, respectively parallel to three given lines in space, provided that two of the latter are not parallel.

If the three components are at right angles to each other, the value of the resultant, estimated with reference to each of the components, is equal to the resultant multiplied by the cosine of the angle which it makes with such component.

Fig. 2.



By the *resolution of forces* is meant the discovery of those forces, their directions and intensities, which can be substituted for some single force of known direction and intensity, without effecting a change in the motion produced, the joint action of the several forces moving the body precisely as it would have been moved by the single force.

Let A M (fig. 2) represent the direction and magnitude of a force, acting on the point A, which we wish to resolve into two forces, acting in the direction A d, A f. The intensities of such two forces may be obtained by drawing M D, M F parallel to A d, A f.

It is only when a force acts in a direction perpendicularly to a body that its full effect upon that body is produced. When the force acts at an angle, only part of it is expended upon the body. To ascertain how much force the body receives, it is sufficient to resolve the force into two others, one whereof is supposed to act perpendicularly, and the other parallelwise to the side of the body. The perpendicular will represent the force actually expended upon the body, and the difference between this component and the original force will give the loss arising from the oblique action of the latter.

To estimate the force with which a body in motion acts upon another body, the mass of the moving body must be multiplied by the velocity, and the result will represent the *momentum*. A ball of two pounds weight, having the same velocity as a ball of one pound weight, has twice the momentum of the latter; but if the larger ball has only half the velocity of the smaller, then their momenta are equal. If a moving body impinges upon one at repose, the latter will have no motion communicated to it, and the moving body will be deprived of its motion unless the momentum of the moving body be greater than the mass of the quiescent body. If that momentum should be large enough to induce motion in the quiescent body, then the velocity of the two, after impact, will be found by dividing the number representing the motion of the moving body by the number representing the united mass of the two bodies, the quiescent body will receive by the impact as many parts of this motion as it has equal component masses, and the moving body will only retain the difference.

When a ball is projected by a cannon, a great velocity is communicated to a small mass. A man-of-war floating with a motion hardly perceptible, will crush to pieces a boat or other similar object between it and the side of a dock. The momentum in both these cases is great, but in one it is mainly owing to velocity—in the other to mass.

When similar amounts of force are expended upon two bodies of unequal mass, their momenta will be the same, but, as a consequence, their velocities will be different, the larger mass moving more slowly.

By means of the momentum acquired by rapid motion, a soft body can be made to cut a much harder one. For instance, a piece of soft iron revolving in a lathe will readily cut a piece of hard steel.

If two bodies, A and B, of equal masses and velocities, meet from opposite quarters, their equal momenta will destroy the opposite motions, and they will be both brought to a state of rest. If the bodies have equal masses but different velocities, or if they have equal velocities but different masses, it is easy to see that the body with the superior momentum will determine the direction of motion after impact; and to find the velocity with which the two bodies move after impact, the difference of their momenta must be divided by the sum of their masses, and the quotient will express the common velocity sought for.

When two bodies of equal mass are moving with different velocities in the same direction, they will move, after impact, with a common velocity equal to half the sum of their original velocities. If the bodies have not

equal masses, the sum of their momenta, being divided by the sum of their masses, the quotient will express their common velocity.

Let M and m represent the masses of two bodies, V and v their velocities, and K and k their momenta; then the foregoing statements may be summed up in these expressions:—

$$1 \ldots\ldots K : k :: M V : m v.$$

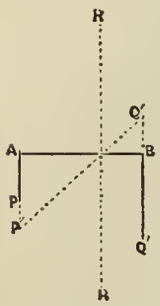
$$\text{Whence } 2 \ldots\ldots V : v :: \frac{K}{M} : \frac{k}{m}.$$

$$\text{If } M = m \; 3 \ldots\ldots V : v :: K : k.$$

$$\text{If } K = k \; 4 \ldots\ldots V : v :: m : M.$$

When two parallel forces, acting in the same direction, are applied to the extremities of an inflexible right line, their resultant divides the line between the points of application of the two forces, in such a manner that each of the three forces (viz., the original forces and their resultant) is proportional to that part of the line lying between the other two. For example, let P Q represent two such forces applied to the extremities of the line A B, and let C be the point of application of their resultant R. Then P : Q :: B C : A C. If the lines A P, B Q, represent the intensities of the forces P Q, then, in order to find the point of application of their resultant, we must extend Q B, so that B Q′ may be equal to P A, extend A P so that A P′ may be equal to Q B, and draw the line P′ Q′, which will cut A B at the point sought.

Fig. 3.



If we substitute for the force R a force R′, equal and directly contrary to it, the three forces, P Q R′, will be in equilibrium. It is evident that, to determine the point of application, B, of the resultant of two parallel forces, P and R′, which act in contrary directions, we must fix the point B, so that we may have the proportion, R′ : P :: A B : B C; and it will be found as easily as the point C, since we know A P, = R′ —P and B Q′ = P. The resultant, Q, is equal to the difference of the forces R′ and P.

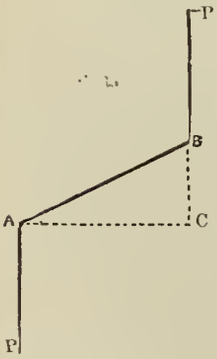
We can, therefore, easily obtain the resultant of as many parallel forces as we choose, it being sufficient to find the resultant, R, of the two first, the resultant, R′, of R and of the third, the resultant, R″, of R′ and of the fourth, and so on.

When two parallel forces are equal, and act in contrary directions, their resultant is = 0.

The French arithmetician, Poinsot, first introduced the method of couples, a theory which has led to very valuable results in mechanical science.

A couple is a system of two forces, such as P and —P, equal, parallel, and contrary, but not applied to the same point. Let P —P be such a couple; the line A B between the points of application of the two forces is termed the arm of the couple, and the perpendicular distance of the two parallel forces A C, the width of the couple. Since we can at pleasure remove the point of application of the force —P, let us suppose C to be the point of application, and the width then becomes the arm of the couple. Such a couple is termed rectangular. The plane in which the arm and the two forces is situated, is termed the plane of the couple.

Fig. 4.



The forces constituting a couple may be removed, and again applied in any manner whatsoever—in its own, or in another plane parallel with its own—provided that they still tend to turn the arm in the same direction, and the new points of application are inflexibly united with the former.

If we were giving demonstrations, this proposition (which is the same with reference to couples, as the arbitrary removal of the point of application in the line of the direction of the force is with reference to a single force) might be first proved for the case of the new arm being parallel with the former; and then for the case of a couple being turned at pleasure in its own plane, around the centre of the arm.

The product of the width of a couple, and the intensity of one of the side forces, is termed the moment of the couple.

Two couples of equal moments in opposite directions, but in the same or in parallel planes, will hold each other in equilibrium.

Two couples of equal moments operating in the same or in parallel planes, and in the same direction, may be substituted for each other, and are consequently equivalent.

When the widths of two couples are equal, their effects are proportional to the side forces.

From this and the former propositions, it may be deduced that couples are proportional to their moments.

Couples are represented by lines in the same manner as single forces; for when a perpendicular, termed the axis of the couple, is erected upon the plane of a couple proportional to its moment, the direction of this axis will represent the direction of the plane, and its magnitude the moment of the couple. If we farther suppose that the revolution which a couple endeavours to effect seems to be always in the same direction—for instance, from left to right—when looked at from the termination of the axis, the direction of the couple may be fitly represented by the axis. If there are several forces, all their planes may be placed so as to be parallel with their original positions through a common point, which may then be assumed as the beginning point of all the axes. Couples then may be compounded exactly according to the same rules as single forces, since it can be proved that the axes of the resultant couples of any two couples of forces, are the diagonals of the parallelogram formed by the axes of the two couples.

A new couple can never be substituted for a force and a couple.

In order that a single force may be substituted for a force and a couple, it is necessary that they should lie in the same or in parallel planes.

All forces whatsoever, operating upon a solid body, can always be reduced to one force and one couple.

STEVENSON'S HARBOUR SCREW-CRAMPS.*

Of all engineering operations, the construction of marine works in exposed situations may be regarded as the most precarious and difficult. The great force to which such erections are subjected, has recently been put to the test of direct experiment, by means of an instrument designed by me for the purpose, which has been named the Marine Dynamometer. The observations which were made with this instrument I lately communicated to the Royal Society of Edinburgh, and as the facts which are there stated are intimately connected with the subject of the following observations, I beg leave to give a brief digest from that Society's Transactions.

"In the Atlantic Ocean, according to the observations made at the Skerryvore Rocks, the average result (of the force of the sea) for five of the summer months, during the years 1843 and 1844, is 611 lb. per square foot. The average results for six of the winter months, during the same years, is 2,086 lb. per square foot, or *thrice* as great as in the summer months.

"The greatest result yet obtained at Skerryvore was during the heavy westerly gale of 29th March, 1845, when a pressure of 6,083 lb. per square foot was registered. The next highest is 5,323 lb.

"In the German Ocean, according to the observations made at the Bell Rock, the greatest result yet obtained is 3,013 lb. per square foot.

"It thus appears, that the greatest effect of the sea which has been observed by the instrument, is that of the Atlantic at Skerryvore, which is nearly equal to three tons per square foot."†

Though the force to which marine buildings may be in some cases exposed is therefore very great, it must nevertheless be borne in mind that the surface of such works which is simultaneously subjected to this force is very limited, and perhaps rarely embraces more than one or two courses of masonry. Every harbour pier of proper construction is of greatly more than sufficient strength, when viewed as a *whole*, to resist the shock of the assailing waves. The friction to be overcome in causing relative motion between even two or three courses, coupled with the resistance offered by the backing, is so great as, in most piers, to ensure their stability. Although when viewed as a whole, therefore, almost every pier is more than sufficient to resist being overturned *en masse;* and the friction and resistance of the backing, consequent on relative motion, is so great as to prevent disunion on the large scale; yet there is hardly any building whose constituent blocks are in themselves weighty enough to resist successfully the dislocating action of the sea. Accordingly, if we inquire into the history of the failure of harbour works, we shall generally find that those have occurred during their construction, and can be traced to the want of due protection while the works have been in progress. And thus it appears that blocks of stone, which are insufficient of themselves, when first laid, to resist the sea, are rendered perfectly secure when kept down by the superincumbent weight of the courses which are afterwards built upon the top of them. The last stones of unfinished courses, also, though equally insecure while in such a state, are found, after the works are completed, and the courses "*closed in*" at both ends, to resist for ages the greatest assaults of winter storms.

Many instances may be adduced of harbours suffering great damage

* Read before the Royal Scottish Society of Arts on 11th December, 1848.

† Trans. Roy. Soc. Edin., vol. xvi.

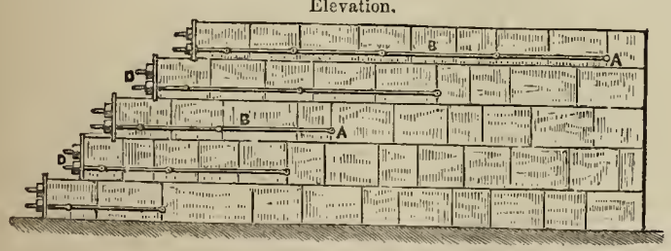
in the course of construction, which have, when finished, successfully withstood the efforts of after gales; and of destruction to a whole work resulting from neglect in speedily repairing some trifling breach in the sea-walls. The north harbour of Peterhead, for example, during its construction in 1819, received damage from a winter gale, which (as estimated at the time) would require an additional expenditure of about £3,400; and this pier has, since it was finished, remained quite secure for the last thirty years. At the construction of Pulteneytown harbour it is recorded, that in 1827 damage was done to the extent of £5,000 in the course of two tides, though it seems now quite secure, after a lapse of nearly twenty years. At Ardglass harbour, which, I understand, cost about £20,000, a breach of 20 feet in extent was, from want of funds, neglected, and the whole of the structure which was above low water was either utterly demolished, or greatly shaken, and has never been repaired. In 1844, I was informed that some of the stones at Dysart pier required, from decay, to be replaced by others, and a hole about four feet square had been made for the purpose, when a gale unfortunately came on, and completely carried away the whole of the outer part of the pier, extending to about thirty yards, with the exception of a fragment of the quay-wall, where many longitudinal and vertical fenders, or stretchers, of wood had been attached. On visiting the ruins about a week after the accident, I was surprised to find that this part of the quay-wall, though wholly deprived of backing, should have so successfully resisted the action of the sea, owing to the support which it received from the fenders. On making inquiries at an eye-witness of the scene, I was told that the sea-wall and hearting were very speedily scattered before the destroying element, and also *that* part of the quay-wall which had not been protected, or so securely protected by fenders. On the other hand, wherever the wall was strongly bound by fenders, the sea encroached very slowly; and that part which was most exposed to injury from vessels rounding their course into the harbour, and which was, in consequence, more strongly and closely bound with horizontal and vertical fenders, resisted successfully the force of the waves.

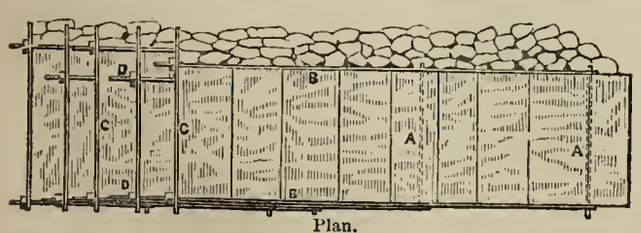
From the foregoing statement of facts, which show us the almost total dependence of one stone on another, and the havoc which may ensue from even a single stone near the bottom of the structure being left insecure, we may readily see the advantage which is to be derived from connecting them together by iron bars and wooden fenders, or wrapping them round with chains, &c.; and hence, in many lighthouses and harbour works, great expense is incurred in joggling the stones, or in connecting them together with oaken tree-nails. The great advantage, therefore, of any contrivance which could be easily, and, above all, quickly applied for this purpose, without involving the expense of jumping holes or cutting the stones, appears very evident. The adoption of such means might confidently be expected to a great extent, to prevent those great losses to which almost all such works are more or less liable during construction, and of which I have given a few examples. The importance of the subject, more especially at this time when the English refuge harbours, involving the expenditure of so many hundreds of thousands of pounds of the public money, have been at length commenced in good earnest, must be my excuse for bringing an untried project before this society.

The accompanying sketches represent two simple implements, which, from their resemblance to others commonly used in carpentry, may be

Fig. 1.

Elevation.

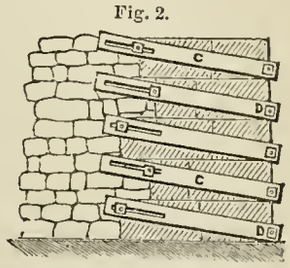




Plan.

termed *Harbour Screw-Cramps*. They are intended to be employed for temporary use in the construction of harbour and other sea works in exposed situations. The principle on which these have been designed, is that of coupling stones together in such a manner that the outermost cannot be removed without dragging the adjoining stones along with it. That represented by the diagrams, figs. 1 and 2, is a screw-cramp adapted for a vertical or nearly vertical sea-wall. It consists of a cross rod of iron, A, inserted diagonally between two of the stones of the work, and on either end of this rod, iron rods or chains, B, are slipped, one set being at the front of the wall, and the other at the back. To prevent the backing of the wall from pressing upon the chains or rods, a small void, like a drain, three inches square, is to be formed at the back of the wall as the work proceeds. At the conclusion of each tide's work, the abutment plate, C, is placed diagonally across the last stone, and the chains or bars are tightened up by means of the capstan-headed screws, D, when the whole is thus bound together, and rendered secure. When the work is again commenced, the abutment-plate, C, is removed, and more stones are set, which are, in like manner, connected with the others at the end of the tide's work by lengthening the chains or rods. After a stretch of sufficient length has been completed, the bars or chains, B, being slackened, the cross rod, A, is removed, and the bars or chains, being now free, are withdrawn. A new cross rod having been previously inserted at some convenient joint, the chains are now attached, and drawn tight as before. In this way, the open end of the work is at each course strongly connected to the stones farther back, without any loss of iron, or expenses for boring or cutting the stone.

Fig. 2.



Transverse Section.

Another *cramp* is designed more particularly for a talus or sea-wall. In this case, one end of the chain is made fast to a ring-bolt, or lewis, in any stone which is at a sufficient distance from the open end, while the kneed abutment or anchor-plate is placed upon the last or outermost stone of each course, when the chains are tightened by means of a draw-screw. This apparatus, in the event of a gale coming on suddenly, could be applied in the course of a few minutes. Instead of the ring-bolt or lewis, a bar or pinch could, in such an emergency, be easily driven down between one of the joints of the talus wall. This kind of screw-cramp could, in cases of great exposure, as a farther security, be also applied transversely or across the courses, so as to extend from low to high water mark.

It is proper, perhaps, in conclusion, to mention that, in order to render the last or outermost stone as steady as the others in the same course, no more strain need be applied to the chains than is sufficient to make up for the defect of friction, caused by its not being in contact on all its four sides with other stones. The amount of the strain required for the chains should, therefore, in each case, be proportioned to the number of the sides of the last or outermost stones which are exposed. It must be borne in mind, however, that, although the chains were slack, the last stone could hardly be carried away unless the chains were broken.

Edinburgh, November 25, 1848.

OPTICAL PHENOMENA OF THE ATMOSPHERE.

Colour of the Sky.—Although the atmosphere is one of the most transparent bodies in nature, yet its transparency is not perfect; its particles absorb one portion of the light they receive, transmit a second, and reflect a third. Hence it is that we are able to see into the celestial spaces; and hence light becomes diffused over terrestrial objects, upon which the rays of any luminary do not directly fall. It is plain to see that the solar light is weakened by its passage through the atmosphere. This may be ascertained by direct experiment; and the transparency of the atmosphere may be expressed numerically, by means of an instrument termed a diaphonometer, invented by Saussure. The greater the extent of atmosphere traversed by rays from a luminous body, the weaker do those rays become. The light of the sun in the zenith is much more dazzling than when it is near the horizon. If it were possible to measure the intensity of the light at different altitudes, we might obtain numerical expressions for the absorbing power of the air; but the results obtained by such instruments as Saussure's helio-thermometer, and Herschel's actinometer, are too vague to enable us to do this.

The blueness of the heaven is owing to the reflection of light by the particles of air, and not to the colour being proper to them. It has been shown that the air has the property of reflecting the blue ray more than the other rays; and that, as the blue rays disappear with the increasing depth of the atmosphere, the red rays become predominant. When the sun is at the horizon, it becomes of an orange or red colour. Saussure's

cyanometer, and Arago's polarimeter, were invented to measure different intensities of blueness. The blueness of the sky, visible from any given spot, is not of a uniform depth; it is deepest at the zenith, and fades gradually as the eye approaches the horizon, when the sky is sometimes nearly white. It deepens from sunrise to mid-day, and from mid-day to sunset it grows lighter. The sky has a greater depth of blue between the tropics, than in higher latitudes; and it is paler over the ocean, than over large expanses of land. The higher we ascend into the air, the deeper becomes the colour, until it becomes almost black.

Crepuscule.—As the sun draws near the horizon on a cloudless day, that portion of the sky which is in the neighbourhood of the luminary assumes a yellow or orange colour, which gradually fades towards the zenith, where the sky is nearly colourless. We shall soon notice a red tint in the east, over against the sun, which attains its maximum at the moment when that body sinks beneath the horizon. A little later, this red tint encloses, in a more or less defined manner, a space coloured deep blue, which constitutes what is termed the crepuscule. In favourable circumstances, a white or yellow band may be seen between the blue and the red, and this has been named the second crepuscule or anticrepuscule. The crepuscular space is caused by the shadow of the earth projected upon the sky; this projection being only illuminated by diffused light, which is blue, it can of course only take this colour. As the sun sinks, the red space in the western sky, which sinks along with it, becomes more defined, and we may then see above it a white space, which we may call the crepuscular glimmer. Sometimes we see a pale and feeble glimmer, lighting up the sky towards the north-west, and rising to a considerable angular height. This glimmer is owing to the secondary illumination which those strata of air that are beneath the horizon, and are receiving the direct light of the sun, cast upon the highest portion of the atmosphere visible to us.

The result of this refraction and reflection is twilight, or the gradual transition from night to day, and from day to night, instead of the sudden appearance of one or the other, upon the rising or setting of the sun.

The *Scintillation* of the stars, or the rapid changes in colour and intensity which they assume to our organs of vision, is partly accounted for, as Arago has shown by the theory of interferences, and partly by the fact, that the rays emanating from the stars have to pass through an atmosphere divided into strata, possessing different degrees of temperature, density, and humidity, and that there are endless changes going on in the position of these strata. The rays, consequently, suffer a different amount of refraction every moment. Scintillation is much more visible in the fixed stars than in the planets, and when they are nearer the horizon than the zenith. Between the tropics there is but little scintillation.

Mirage—Is the name given to an optical illusion, partly caused by the refraction of light through atmospherical strata with different densities, and partly by its reflection, when it falls upon a stratum of much greater rarity than that through which it first passed. Sometimes the illusion presents the appearance of a large sheet of water, wherein objects are reflected. Quintius Curtius speaks of a desert in Asia, which, under the influence of the sun's heat, wore the appearance of a deep and extensive sea. This phenomenon is very frequently perceived in Egypt, (where it added to the miseries of Napoleon's soldiers when dying of thirst,) in Persia, (where it is termed *Serab*, or miraculous water,) and in other places where are extensive plains exposed to a burning sun. It is sometimes seen on the coasts of England and France,* where an expanse of sand affords a favourable locality for its production. The following is Mr. Bryant's description of the phenomenon, as seen by him in crossing an American prairie: "Lakes, dotted with islands, and bordered by groves of gently waving timber, whose tranquil and limpid waters reflected sloping banks and shady islets in their bosom, lay spread out before us, inviting us to stray from our path, and enjoy their cooling shades and refreshing waters. These fading away as we advanced, beautiful villas, decorated with all the ornaments of suburban architecture, and surrounded by gardens, shaded walks, parks, and stately avenues, would succeed them, renewing the alluring invitation to repose. These melting from our view, in another place a vast city, with countless columned edifices of marble whiteness, and studded with domes, spires, and turreted towers, would rise upon the horizon of the plain, astonishing us with their stupendous grandeur and sublime magnificence. The whole distant view around us at this point, seemed like the creations of a dream, or the effect of enchantment."

Monge, one of the scientific men who accompanied Napoleon in his expedition to Egypt, thus describes the illusion,—"When the cool of evening comes on, after the surface of the earth has been heated by a burning sun, the more prominent objects of the distant landscape seem to stand amidst a flood of waters. The villages appear to rise out of a vast lake, and under each is seen its inverted image, exactly as if it were reflected from a sheet of water. On approaching, the illusory images vanish, and on arriving at the village, we are still surrounded by arid wastes of sand, whilst the deception is renewed at some distant point."

In another kind of mirage, called lateral mirage, an object, instead of being reflected vertically, is reflected horizontally. The French coast on the Dover Straits seems sometimes brought so near the English shore, that persons acquainted with it can recognise all the localities with perfect ease.

A third kind of mirage is called suspension. Distant objects, ordinarily not visible, appear floating in the air; sometimes visible objects have an inverted image directly under them, as if reflected in water. Captain Scoresby, sailing off the Greenland coast in 1822, saw in the air an inverted image of his father's ship, then 30 miles off, and, consequently, below the horizon.

The phenomenon called Fata Morgana, seen in the Straits of Messina, and those termed by sailors the Flying Dutchman, Enchanted Island, &c., are modifications of mirage. The Giant of the Harz Mountains is also an appearance attributable to the same cause, as well as a phenomenon witnessed by Mr. Bryant, in traversing with a party a large grassless plain, covered with a white crust of saline matter, in North America. There appeared in front, at an apparent distance of from three to five miles, the figures of 15 or 20 men and horses, some of the men being mounted, others on foot. They appeared to be approaching the party of travellers at a rapid rate. The figures then became multiplied into three or four hundred. On observing the phenomenon more closely, the figures were seen to perform movements similar to those of the travellers. A single figure in advance of the rest was noticed, which seemed to one of the party to resemble himself. He wheeled suddenly round, at the same time striking his arms out. The figure went through the same motions. He then took several long strides—the figure did the same. These actions were repeated with the same result. The fact was then clear, that the whole array was composed only of reflections of the travellers upon an atmosphere loaded with minute particles of salt, and in a short time the shadowy host melted entirely away.

Halos.—When the light of a heavenly body meets with condensed vapours, the particles of which are vesicular spheres, or frozen, it becomes so reflected and refracted in its passage to our eye, that various phenomena, termed coronæ, halos, parhelia, &c., are produced. Coronæ are coloured circles concentrically arranged round the sun and moon, sometimes to the number of four. Like all the phenomena of diffraction, they have the red at the outer edge, and the violet within, a disposition similar to that of the colours of the first rainbow. They are formed by the suspension of a thin cloud, composed of minute spheres or globules of water between the sun and the spectator. An analogous phenomenon may be artificially produced by looking at the sun, moon, or the flame of a candle, through a piece of glass covered with the dust of lycopodium. Fine concentric coronæ will then be seen to the number of three or four. Solar coronæ cannot well be observed, on account of the brilliancy of the sun, without using a smoked glass, but they may be often noticed about the moon by the naked eye. The most beautiful solar coronæ occur when mists rise at daybreak from the bottom of valleys.

When the sun is near the horizon, and the shadow of an observer is thrown upon a surface covered with dew, or upon a cloud or mist, the shadow is seen to be surrounded by a vivid light, especially about the head, like an aureola. This phenomenon is common in the polar seas, and it has been often observed in alpine countries. These images have received the name of Anthelia. Lamartine relates, that when he was on the summit of Lebanon, he saw his head surrounded by a luminous aureola.

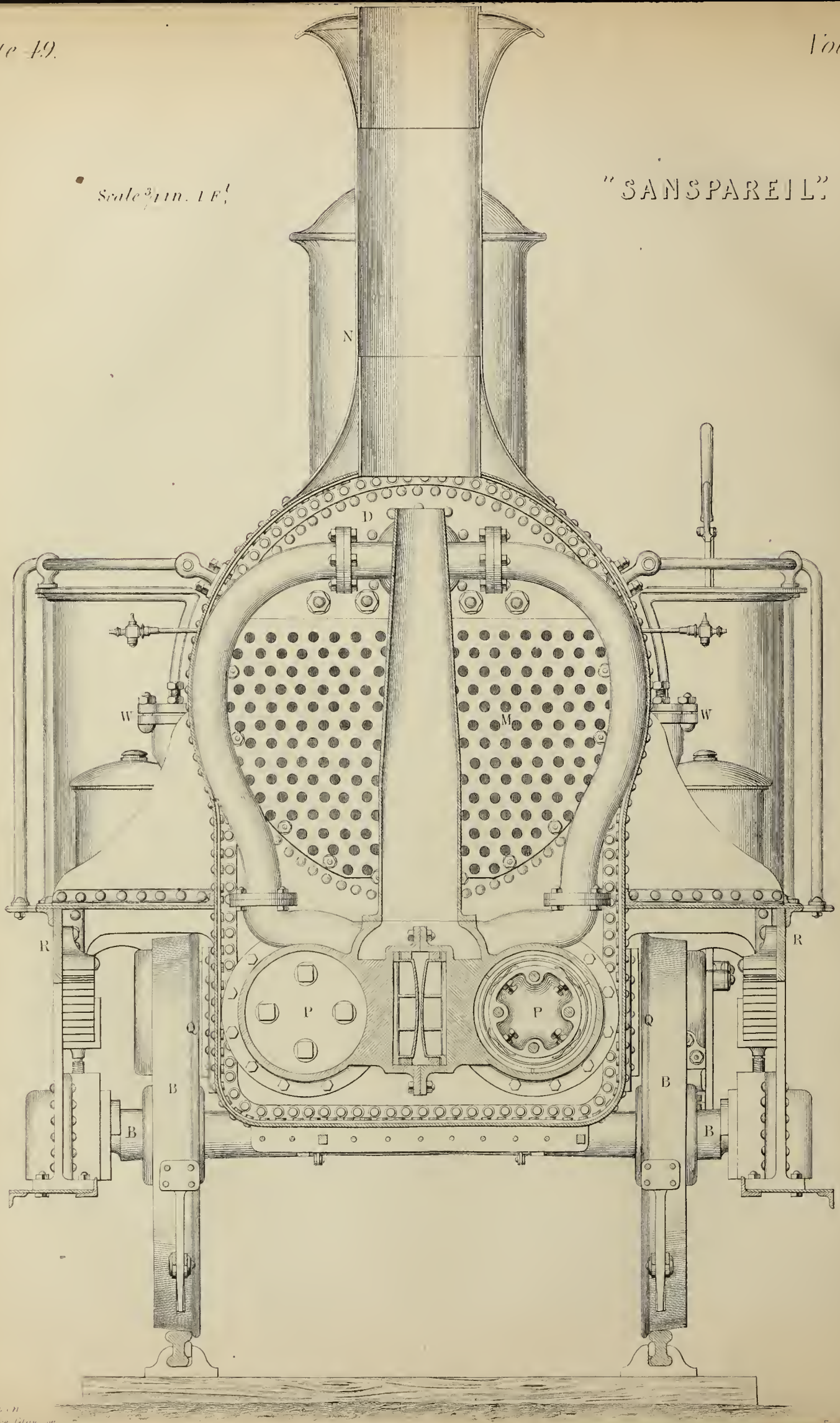
Halos, properly so called, are coloured rings, with the sun or moon in their centre. The first of these circles (termed the ordinary halo) has a radius of 22°; the second halo is 46° distant from the sun; and the third, which is seen only very seldom, is 90° distant. The two first are distinguished from coronæ, by having the red tints on their inner edges, a consequence of their being produced by refraction. By looking at the sun through a piece of glass incrusted with a solution of alum allowed to crystallise, the phenomenon of halos may be artificially produced.

The atmospherical condition which gives rise to halos, produces also sometimes a white band parallel with the horizon, and passing through the sun or moon. It rises as the luminary rises, so that the radius of the complete circle would be equal to the zenith distance of the luminary. When the band intersects the halo which it accompanies, faint images of the sun or moon are seen. These images, when the sun is the luminary,

* There is a sonnet by Wordsworth, commencing with the line—
"Inland, within a hollow vale I stood,"
which refers, we suppose, to some modification of mirage, seen by the poet on the south-east coast of England.

Scale 3/4 in. 1 Ft.

"SANSPAREIL."



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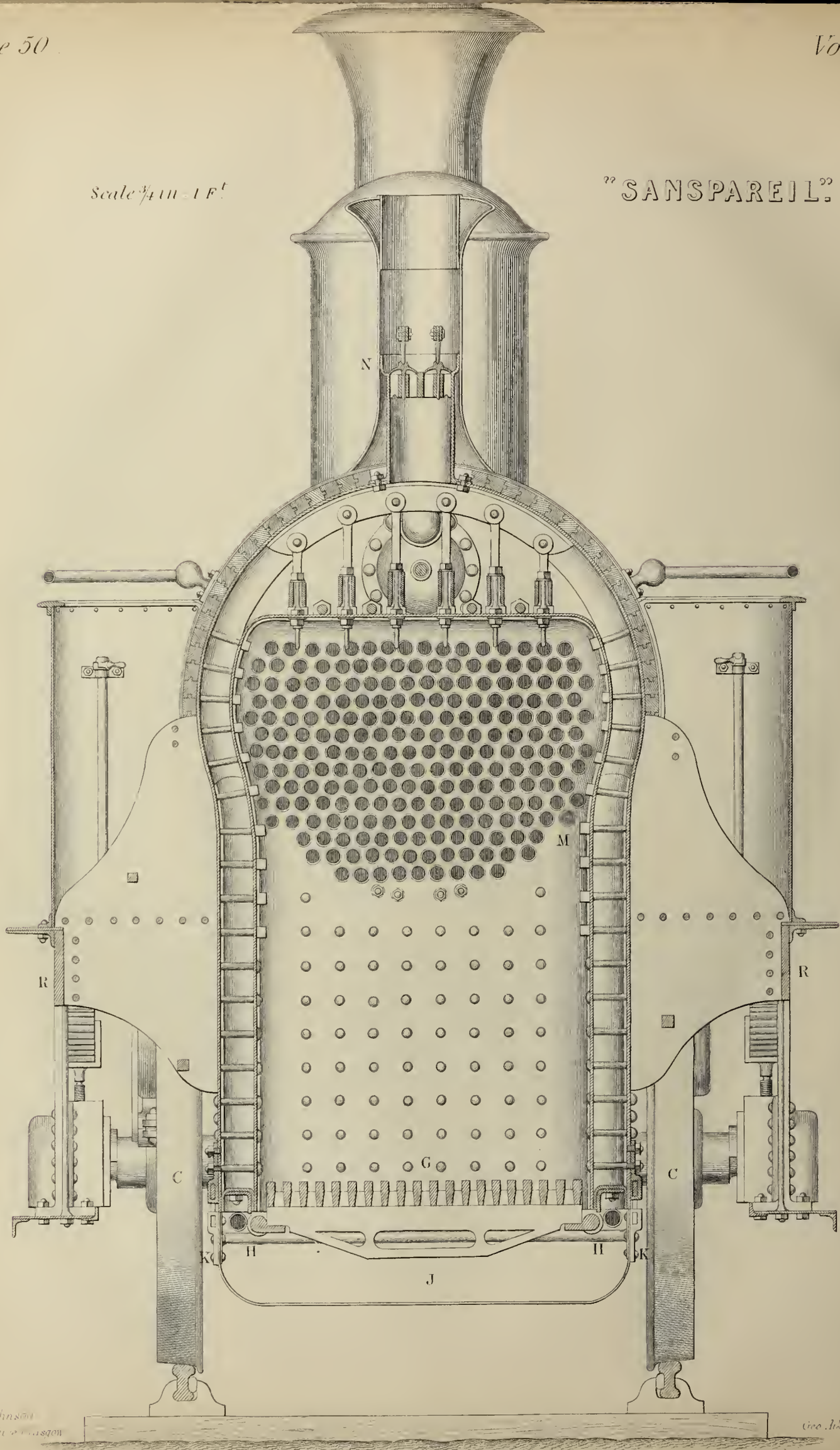

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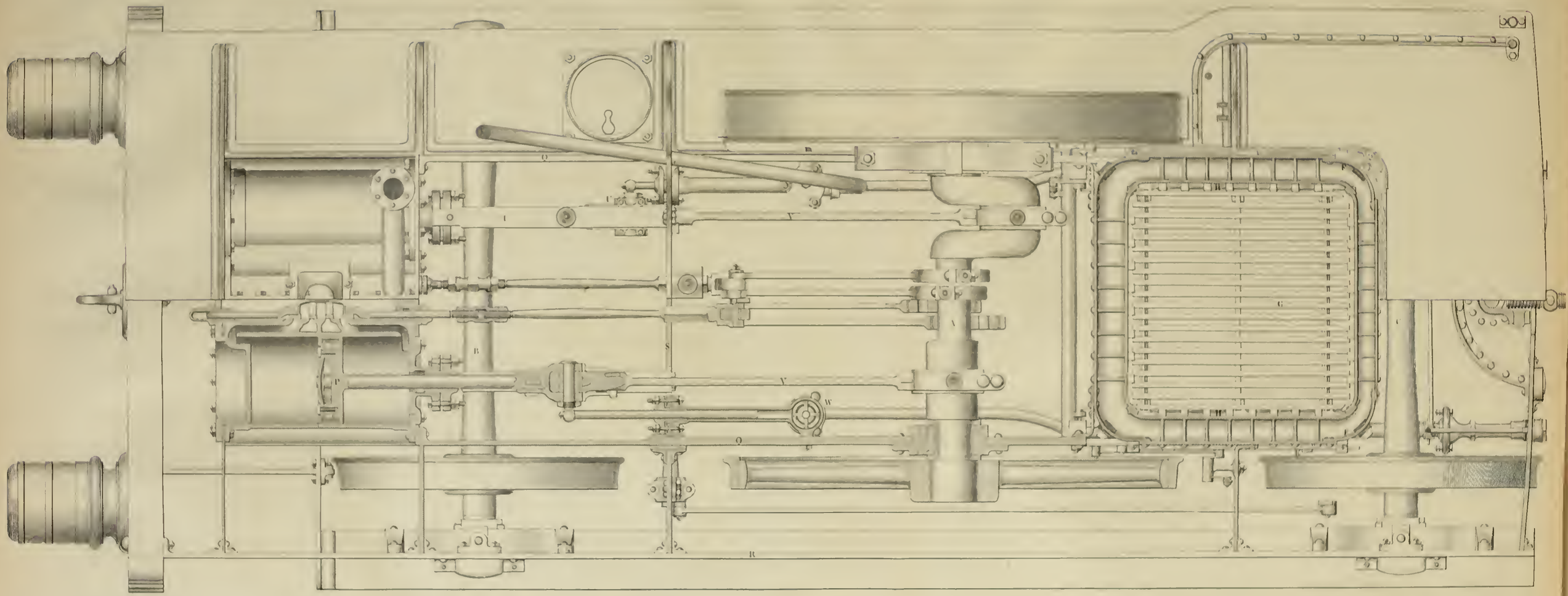

Scale 0 1 2 3 4 5 6 7 8 9 10 feet

Fig 1

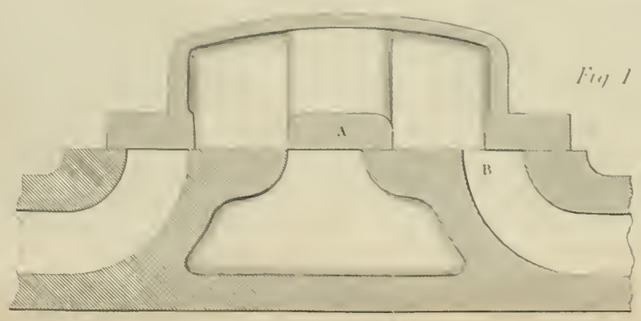

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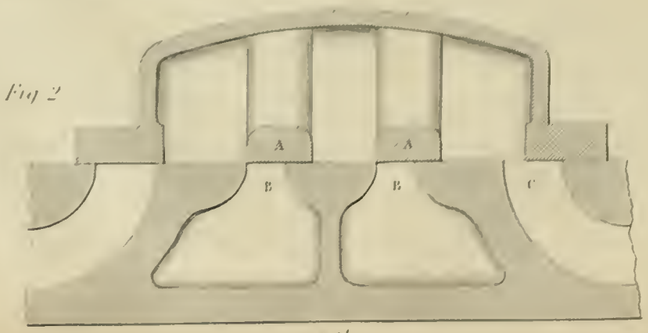
Fig 2



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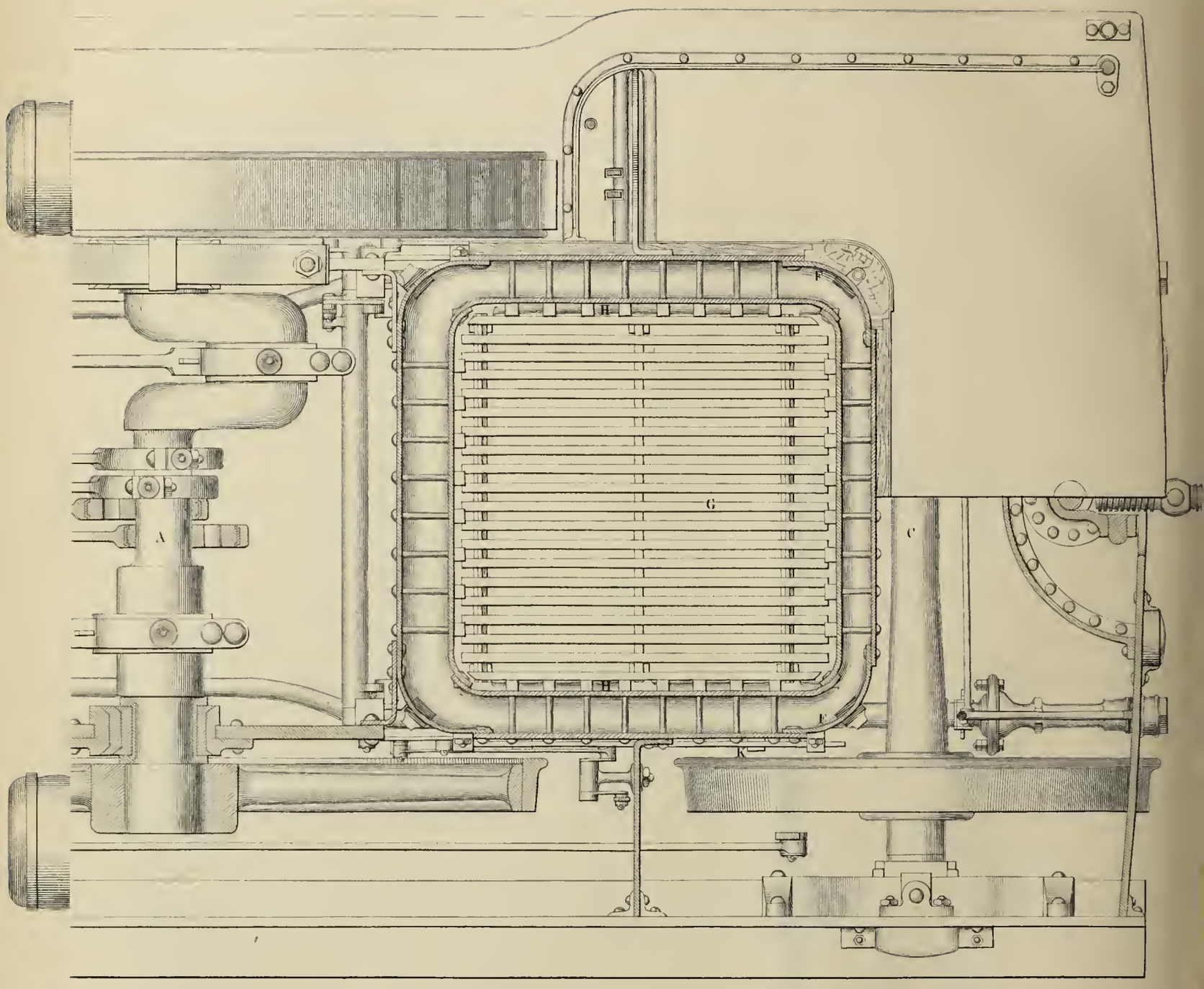
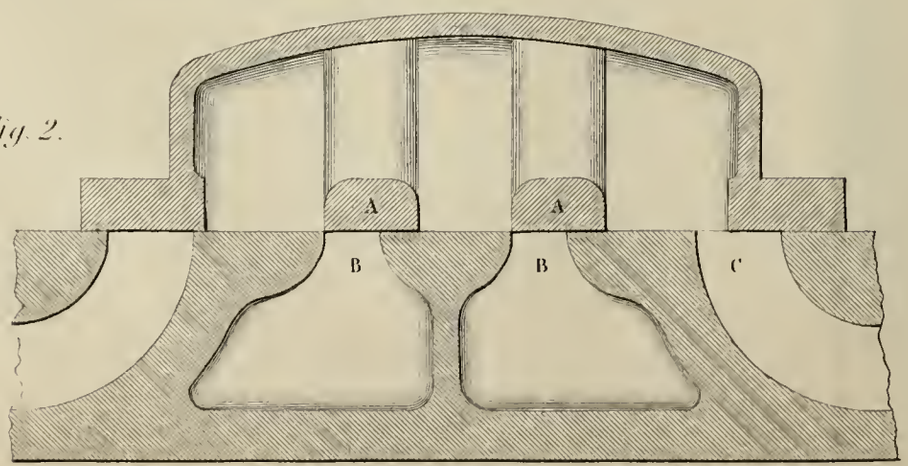


6 7 8 9 10 Feet

Fig. 2.



1/3rd

are termed parhelia; when it is the moon, paraselenæ. Sometimes another band of white light is seen to pass vertically through the luminous body, so as to form, with the other band, a cross in the interior of the halo, and such a figure may now and then be observed when no halo is visible. In Captain Back's narrative there is a drawing of a very curious lunar phenomenon, in which the moon is surrounded by a halo containing a white cross, and at the extremity of each limb of the cross there is a paraselenæ. Occasionally, portions of circles, and curves of contrary flexure, are attached to the bands and circles above described.

Parhelia (mock suns) and paraselenæ (mock moons) are always visible at or near the points where two circles or bands intersect. They are coloured like a halo, and have frequently a prolongation like a tail.

The phenomena of halos, parhelia, and parheliacal bands, are supposed to be owing to a multitude of crystals of ice, or flakes of snow, suspended in or falling through the atmosphere in the shape of equilateral prisms.

The *Rainbow* is caused by the prismatic refraction of the sun's beams by drops of falling rain, and it is always seen in that part of the sky which is opposite to the sun, the spectator being between them. Let us take a single drop of rain, and suppose a ray of light to enter its upper part. This ray will suffer refraction on its passage through the drop, and when it reaches the other side it will be reflected towards the spectator, and will issue from the lower part into the atmosphere. At its point of emergence it will be again refracted, and suffer the prismatic dispersion. On the outside of, and concentric with, the principal bow, there is usually seen another, in which the colours are arranged in a reversed order. In the principal arch the red is on the outer edge, the violet at the inner edge. The secondary bow is formed by rays of light entering the lower part of the drops, being there refracted, suffering reflection at the back in the direction of the upper part, where they are reflected a second time, and are then sent to the front of the drops, where they emerge into the atmosphere. In this way they suffer two reflections and two refractions; consequently, the colours are fainter than those of the first bow, a greater quantity of light being lost by transmission through the drops. The centre of a rainbow is always placed upon the line which passes through the centre of the sun and the spectator's eye; therefore, when the sun is in the horizon, both rainbows will be semicircles; but if it be above the horizon, a segment less than a semicircle will be visible; when it has an altitude of 42°, the primary bow is no longer seen; and at a height of 54°, the secondary bow ceases to be visible. If, however, the spectator stand on elevated ground, and the sun is below him, the visible arc is larger than a semicircle, and the arc is large in proportion to his height above the sun. A coloured arch, similar to that of the rainbow, may be seen in the spray of a waterfall when the sun is shining upon it. It may be remarked, that each spectator sees the prismatic colours thrown from different drops of rain, and, consequently, each individual has his own rainbow.

*Polarising Power of the Atmosphere.**—As far back as 1810, Arago discovered that light becomes polarised on its passage through the atmosphere. It was subsequently found that the maximum polarisation takes place in a circle about 90° distant from the sun. Brewster has constructed a map of the polarising power of the sky, in which the lines or curves of equal polarisation are seen to be related to neutral points or poles of no-polarisation. Of these neutral points three are principal; and one of these, called after its discoverer (Arago), is placed about 18½° above the point of the sky which is directly opposite to the sun. It is above the horizon of Great Britain all day, from the middle of November to the end of January; but during the rest of the year it does not come above the horizon until the sun has approached within 11° or 12° of the horizon, and it does not disappear until the sun has risen 11° or 12° above the horizon. A secondary neutral point accompanies this principal neutral point. Another neutral point (Babinet's) is placed about 18½° above the sun, and is in sight as long as the sun is visible. A third neutral point (Brewster's) has an average distance of 12° or 13° below the sun. The second and third points meet in the sun's centre, when that body is in the zenith. The polariscope and polarimeter may now be considered as meteorological instruments. It can be discovered by the former when a fog covers the earth, whether the sky above it is clear or obscure, or even whether it is scattered with isolated clouds leaving clear intervals. Professor Wheatstone has constructed an ingenious instrument, which he calls a polar clock or dial, for determining the apparent solar time as long as the sun's rays illuminate the atmosphere. His method consists in determining the diurnal changes of the plane of polarisation at the north pole of the sky. (See his communication to the British Association, 1848.) Arago affirms that the moon's rays contain a considerable quantity of polarised light.

* It may be useful to remind the reader that light is termed polarised, when, after having been subjected to reflection or refraction, it is found to possess the following properties:—1. It cannot be perfectly reflected from a reflecting plane in every position in which such plane may be placed. 2. It cannot be perfectly transmitted through a transparent body in any position in which such body may be placed. 3. It is not subject to double refraction in a body having this power over ordinary light, except that body be placed in certain positions. Light is subject to degrees of polarisation, in order that a ray of ordinary light should be converted into polarised light possessing its *maximum* polarisation; in other words, in order that it should be *perfectly* polarised, it is requisite that it should fall on the reflecting or refracting body at a certain angle, which angle differs according to the nature of the body employed, but remains the same for all bodies of the same nature. Brewster's expression of the law is this: the tangent of the angle of complete polarisation is invariably equal to the index of refraction.

LOCOMOTIVE PASSENGER ENGINE "SANSPAREIL."

(Illustrated by Plates 46, 47, 49, 50, and 53.)

The last of the plates of this engine, enumerated above, completes the series of five which have been scattered through parts 25, 26, 27, and 29 of this Journal. These are, as already described, a longitudinal elevation and corresponding section, plates 46 and 47; a transverse section through the smoke-box, cylinders, and blast-pipe, plate 49; a similar section through the furnace, fire-box, and safety-valves, plate 50; and a complete plan, with semi-horizontal section, and details of valves, plate 53. This last affords a very full insight into the construction of the engine, as it furnishes horizontal sections through the cylinder, valve, and steam passages, connecting-rod joint, force-pump, framing, driving-wheel, eccentrics, and fire-box, with a corresponding elevation of the mechanical details as they would appear with the boiler removed.

The descriptive matter already given in part 26, leaves little to be said further than a reference to the slide-valves, which may be explained in connection with the detached figures 1 and 2 on plate 53. Fig. 1 is a longitudinal section through the valve and steam ports of the old "pass-over" slide, introduced by Mr. Hackworth in the "Royal George" engine, of Stockton and Darlington renown. Having been so long in use, the principle of this valve is tolerably well understood. It is formed with a central bar, A, for closing the exhaust port, whilst a portion of the steam in the cylinder is passed from one end to the other, instead of discharging the entire quantity into the atmosphere, as in the ordinary plain valve.

At slow speeds, this contrivance added considerably to the economic value of the valve, but, when a certain rate was exceeded, an objection appeared in the shape of the utter impracticability of obtaining an amount of area in the exhaust port, at all proportional to the steam port, whilst discharging from the cylinder.

To illustrate this defect, if we suppose the induction port, B, in discharging the steam, to be allowed to open ⅜ths inch for "pass-over" before the eduction port opens at all, we find that it loses irrecoverably an amount of area equal to that allowed for the "pass-over," which, owing to the impossibility of drawing off the steam from the opposite end with sufficient rapidity to afford an unresisting medium for the progress of the piston, must seriously affect the working of the engine.

Practice laid bare the fact, that, although economical at slow speeds, these valves were, from the throttled exhaustion, unfitted for working efficiently at high velocities, as the obstruction to the effluent steam far more than counterbalanced the theoretical gain by passing over the steam.

In the recently-patented valves of Mr. Hackworth, one of which is delineated in section in fig. 2, not only has this defect been quite removed, but additional efficiency is actually derived from a high working speed. The improvement consists in the formation of two or more bars, A A, in the valve, in place of one, with a corresponding modification of the cylinder eduction ports, B B; this affords every facility for a speedy exhaust. The position of the valve in the figure is that in which the "pass-over" is just cut off whilst the eduction ports, B B, are on the point of opening; and although there is an opening of ⅜ths inch at the induction port, C, which is supposed to be discharging out of the cylinder—from the fact of opening the two exhaust ports, B B, an area for exhaustion, equal to the induction port, is instantaneously obtained, and multiplied in the proportion of two to one; so that, in this valve, we possess the power of discharging the steam with double the rapidity, and under circumstances the most advantageous for the efficient working of the engine.

In working, the induction ports are generally opened ⅜ths inch—never more than ⅝ths. The rubbing surface is also greater in these valves, in proportion to their area, than in those of the ordinary kind, and this surface is obviously more equally distributed over the cylinder face.

Of the resultant advantages of this arrangement, the first is the economy of fuel—ranging from 25 to 30 per cent. over the common valve. Again, as the pistons are rapidly progressing from one end of the cylinder to the other, the passing over of a portion of the exhaust steam to what is becoming the induction end, so as to form an elastic cushion for sustaining the shock arising from the change of action at

each stroke; and this steam is, besides, always in active readiness, like a compressed spring, instantly to throw its elastic force into operation at the termination of each stroke, for the reversing of the piston's movement.

This cushioning of the pistons, and the gradual restraining of the momentum, diminishes in a considerable degree the evil consequent upon reciprocal motion—the advantage being apparent, when it is remembered how severe is the effect of the blow given by the instantaneous introduction of a volume of steam from the boiler, as an opposing medium of resistance to the piston in the rapid movements of a modern locomotive. The sharpness of the shock has a good deal to do with the rapid wear of the mechanism; for a very powerful lateral stroke is given by the usual application of the steam, to stay the piston at the termination of the stroke; and this action on each piston may be regarded as a blow struck upon a lever, the violence of the impact being multiplied in proportion to the transverse distance of the cylinders' centres from the centre of the engine's mass. The wide mouth of the blast-pipe, as shown in plates 47 and 49, is evidence of the satisfactory action of the improvement, as regards working with a soft blast, which carries with it two or three well-known and appreciated advantages.

The performance of the "Sanspareil" is given in a tabular form below, and with this we may conclude our remarks upon it.

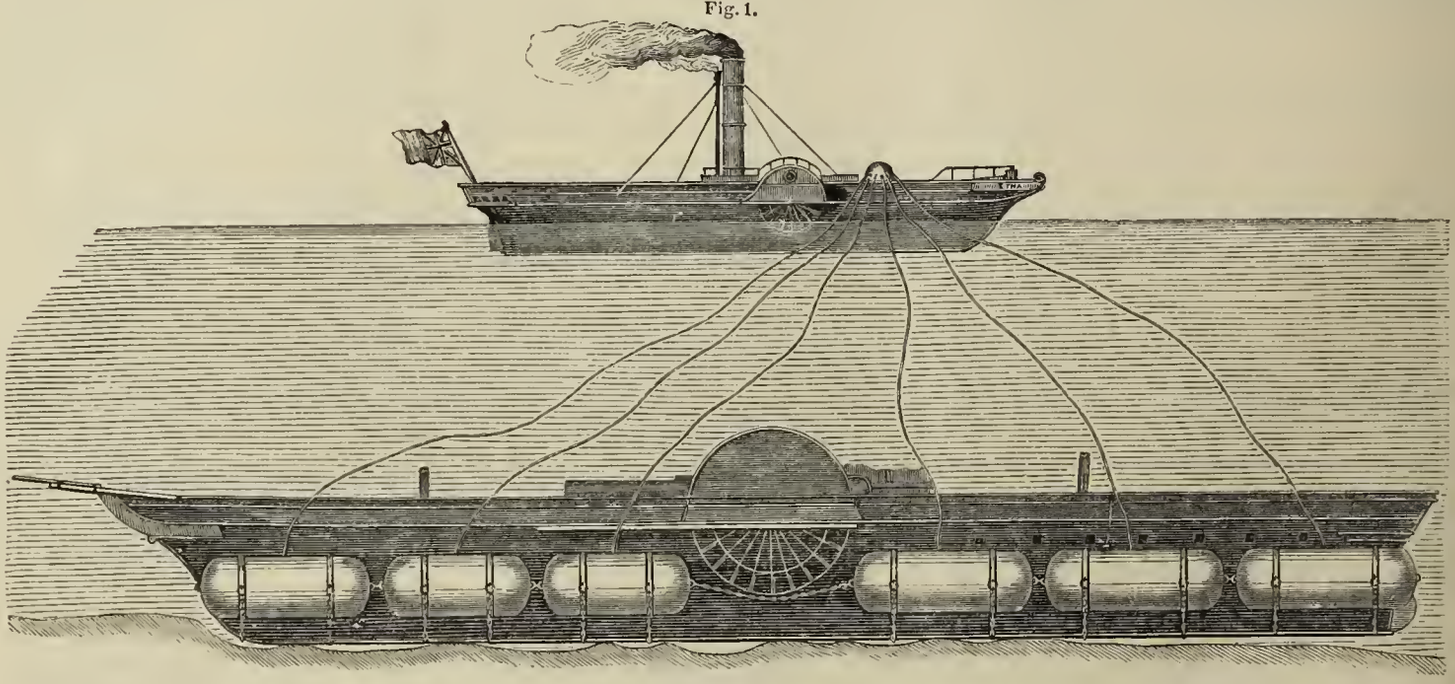
EXPERIMENTS.

Number of Carriages.	Number of Tons.	Number of Miles travelled.	Time on the Distance.	Number of Stops.	Time lost in standing at the Stations.	Actual Time running, including getting into Speed and coming to a stand at the Station.	Cwts. of Coke consumed, including Raising Steam	Gallons of Water evaporated.
			H. M. S.		M. S.	H. M. S.		
	200	45	1 45 0	1	10 0	1 35 0	21	1806
	90	45	1 45 0	2	8 0	1 37 0		
17		45	2 10 5	12	16 3	1 54 2	17	1512
8		45	1 42 50	12	10 54	1 31 56		
13		45	1 53 30	12	15 15	1 38 15	16½	1451
10		45	1 46 40	12	16 15	1 30 25		
11		45	1 30 0	5	9 45	1 20 15	13	1155
6		45	1 3 0			1 3 0		

LIFT-APPARATUS FOR THE "ORION."

The peculiar circumstances attending the wreck of the "Orion," and the numerous plans proposed to raise her, have created an amount of interest in the matter, which the general safety of modern steam-boat travelling has happily rendered very uncommon. All chance of raising her whole is however now gone, as the recent gales have combined with the ground swell to bring about her partial breaking up before it was

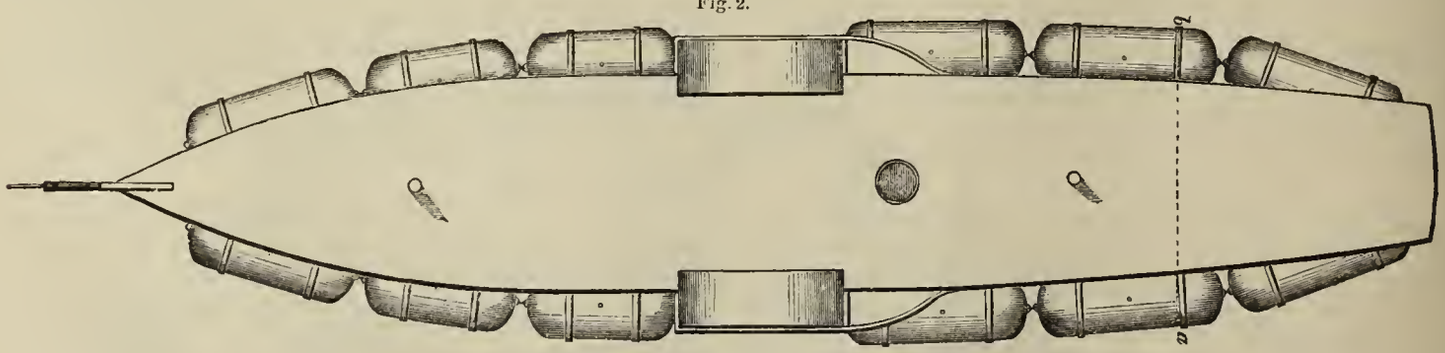
Fig. 1.



expected, and she is now advertised for sale as she lays—to be lifted piecemeal by any one who is adventurous enough to risk his capital, and try his skill upon her.

It may yet not be out of place to record the plan for lifting her, which had received the sanction of the interested parties, and which, but for the late destructive action of the wind and waves, would have been actually

Fig. 2.



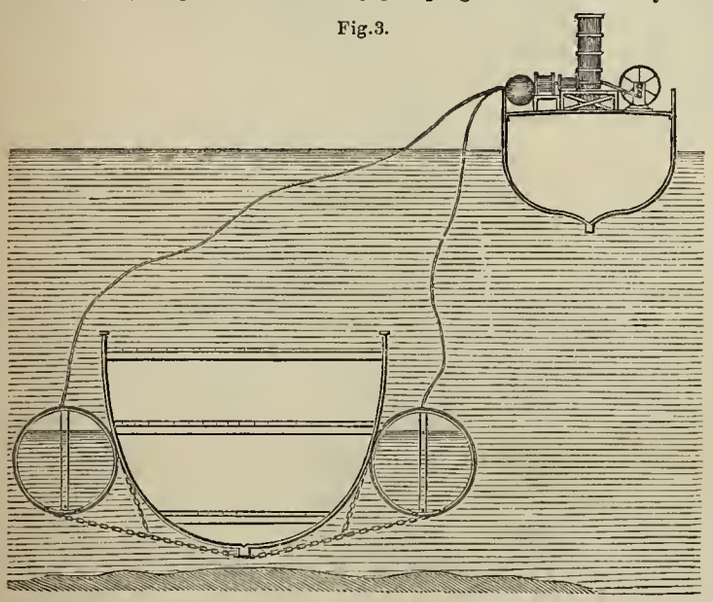
put in practice. The plan in question was originated by Mr. George Simpson, C. E., of this city, who proposed, and drew out the necessary details for its execution.

In referring to our sketches illustrative of the arrangement, fig. 1 is a side elevation of the "Orion" as she lay on her keel in about seven fathoms water; fig. 2 is a corresponding plan in outline, and fig. 3 is a

transverse section of the vessel through the line *a*, *b*, on a larger scale.* The views represent the apparatus as prepared for action, but before the lifting has commenced. The lifting power is obtained from a set of twelve cylindrical air vessels, such as common steam-boilers, the aggregate length of which, if placed end to end, would be 360 feet, the diameter of each being 12 feet. Each of these air vessels has two broad wrought-iron bands passed round it, for the purpose of attaching to it, a chain passing beneath the keel, and attached to each pair of opposite vessels. The plan shows the position of these air vessels, six being on each side.

The diameter of each vessel being 12 feet, presents an area of ($12^2 \times .7854 = 113.09$) 113 square feet; and this multiplied by 360, gives 40,680 cubic feet as the content of the series. When filled with water, their weight would be (40,680 × 62½ lbs. per cubic foot = 2,542,500 lbs. ÷ 2240 = 1,135) 1,135 tons. Then deducting from this the weight of the material of the vessels and their connections—which may be taken at 135 tons—there remains 1,000 tons of effective buoyant power, supposing the whole to be emptied: this being rather more than the supposed entire weight of the ship and remaining cargo as she now lays in the water. This buoyancy might be obtained by pumping the water directly out of

Fig.3.



each vessel; but such a plan would involve a great amount of complexity and very considerable expense—one large item alone, arising from the necessity of making the buoyant vessels excessively strong to resist the external pressure of the water, there being no internal pressure to equipoise it. Instead of this, the water was to be ejected from the vessels simply by compressed air. The sketches show how this is accomplished. The deck of the small steam-tender carries a little horizontal direct action engine, the piston-rod of which projects through the bottom of its cylinder, and has upon its end the piston of the air-pump, which is thus worked by the direct action of the steam. A pipe from this air-pump cylinder opens into a spherical receiver placed just within the steamer's gunwale, in a line with the air pump. From the top of this receiver a flexible gutta percha tube opens a communication with each buoyant air-vessel, as represented in figs. 1 and 3. Each tube is connected to the top of its vessel, and an internal fixed tube in each conducts the air nearly to the bottom, as in the two sections of the vessels in fig. 3. The air escapes from this fixed tube by side openings, just above the bottom; and as it is pumped in, it rises through the water contained in the vessel, and accumulates at the top—ejecting the water by the openings in the bottom of the vessels, which are in direct communication with the sea.

If it should be necessary to eject the whole of the water from the vessels, the bubbling up of the air at the surface of the sea would show when this point is reached. In this plan no ejection-valves are required, as, even if the pipes are withdrawn after the vessels are made buoyant, no air escape can possibly take place, as the internal tubes have no communication with the vessels, except by the small holes near the bottom, and the water acts as its own valve in preventing any escape by them.

In the case of the "Orion," where the keel is on a hard, rocky, and uneven bottom, no difficulty would have been felt in passing chains beneath her, and this system is evidently the safest that could be adopted. If the keel, however, had been deep in sand, a very good hold for the buoyant vessels may be obtained by passing a chain horizontally round her, pretty low down, so that the upward strain would give the chain a firm bearing upon the higher and more expanded portion of the ship. Assistance may also be obtained from the dead lights; or, if these are not available, a temporary case may be made partially to surround the ship, as a means of connecting the vessels.

As the vessels would be fully 30 feet beneath the surface of the sea, the air supplied to them must necessarily be at a pressure of two atmospheres; therefore, in making calculations for raising in this way, this important item must be kept in mind.

If we take the air-pump cylinder at the dimensions of 4 feet stroke by 3 feet diameter, the number of strokes necessary to inject the required quantity of 40,680 cubic feet of compressed air would be 2,906, which, at 50 strokes per minute, might be accomplished in one hour.

As the air inside the vessels is at a pressure only very slightly higher than the fluid pressure surrounding them, they may be made of very slight materials. In putting this scheme into practice, the buoyant vessels should have no more water in them than would be necessary to sink them, as all water beyond this quantity would involve just so much loss in dislodging it afterwards; and as the "Orion" is sunk in water which is constantly troubled with currents, no more elevation should be given to her than would be sufficient to clear intervening obstacles, until she could be towed into smooth water, preparatory to raising her to the surface for conveyance to harbour.

* All the views of the ship having been prepared from her exact measurements.

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RECENT PATENTS.

ORNAMENTAL FABRICS.

T. Auchterlonie, *Glasgow, Calico-Printer.—Enrolled July 13th*, 1850.

The object of this clever invention is the ornamentation of various fabrics, by attaching to their surface, devices or figures cut out of other fabrics, so as to produce a most effective kind of relief ornament at the cheapest possible rate. All classes of fabrics may be thus treated, the devices or ornamental figures being cemented to the surface of the fabric by a solution of that most useful substance, gutta percha.

As an illustration of the working of the process, we may suppose the fabric to be ornamented to be a barége or mousseleine-de-laine, intended for ladies' dresses, and the ornamenting figures to be of satin or velvet. Whichever of these is used, receives a coating of gutta percha on its wrong side; and, when dry, the piece is cut up into narrow strips, and passed between a pair of rollers, for the purpose of cutting out the devices —which may be leaves, or centres of flowers, or flowers themselves. The figure is formed in relief, upon the surface of one of the rollers, which resemble the ordinary milling rollers of engravers to calico-printers, the corresponding roller being plain, and made of soft iron. The strips of the ornamenting fabric are passed between these rollers, which are weighted sufficiently to cut out the figures—or, rather, to sever them partially, so that they may be removed by hand. The fabric to be ornamented is now stretched over a hot table, and each device is placed upon it in its intended position, and then pressed down by a small presser held in the hand of the attendant. This pressure brings the gutta percha coating into firm contact with the surface of the fabric, on which it is placed, and the heat from below causes it to adhere firmly. The ornamented goods are finally finished by a hot rolling or pressing process—being passed through a species of calender, the centre roller of which is heated by steam.

The effect of this system of ornamentation is beautifully brilliant, as the figures stand out from the fabric in bold relief, and the tenacity of the adhesive solution precludes the chance of their coming of.

The claims are—

1st. The system of ornamenting fabrics in relief, by the attachment of figures or devices to the surface.

2d. The use of the roller cutting-out apparatus.

3d. The use of a guide-frame for setting out the positions of the figures.

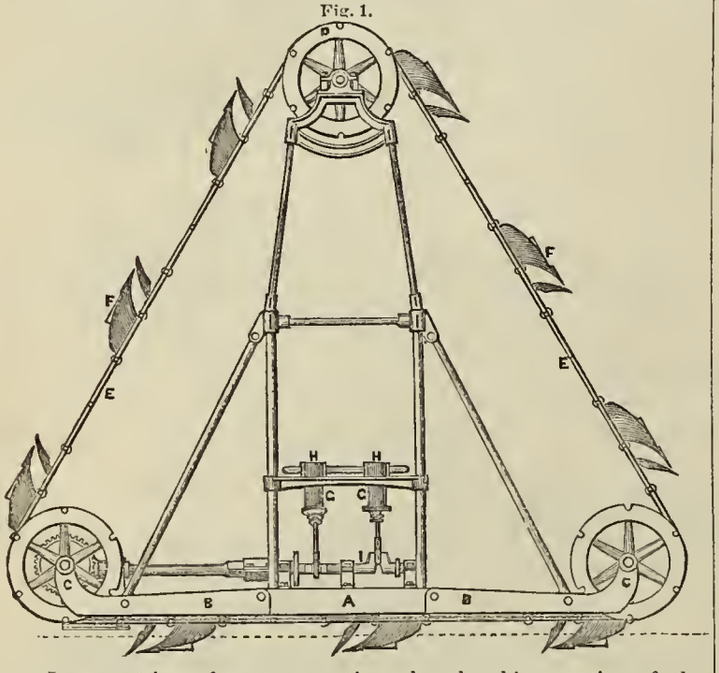
PROPELLING AND PLOUGHING.*

G. Callaway, *and* R. A. Purkis.—*Enrolled May* 24, 1850.

The improvements in propelling, specified under this patent, differ only in details from Ruthven's and Bodmer's systems—the propelling power being obtained by the reactive effect of a pair of fan wheels, placed vertically near the stern of the vessel, one on each side the line of keel. Provision is made for steering by the variation of the angle of discharge of the water in addition to the ordinary rudder. The steering wheel shaft carries three steering wheels. The first is fast on the shaft, and works the rudder; and the other two are loose, but connected by pulley gearing with the horizontal shafts below deck, one for the discharge aperture of each fan.

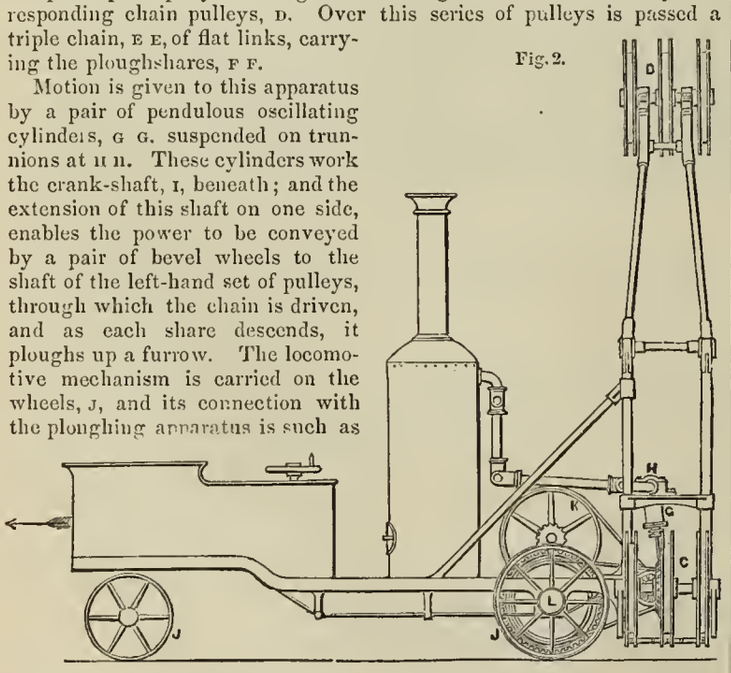
The second head refers to a steam-plough. Fig. 1 of our engravings is a front elevation of the plough, and fig. 2 is a corresponding side view.

Fig. 1.



A, Is a cast-iron frame, supporting the ploughing portion of the apparatus, and B B are side plates of wrought-iron, carrying at their outer ends the sets of chain pulleys, c c. Above is a tall framework, composed principally of wrought-iron tubing, and intended to carry corresponding chain pulleys, D. Over this series of pulleys is passed a triple chain, E E, of flat links, carrying the ploughshares, F F.

Fig. 2.



Motion is given to this apparatus by a pair of pendulous oscillating cylinders, G G, suspended on trunnions at H H. These cylinders work the crank-shaft, I, beneath; and the extension of this shaft on one side, enables the power to be conveyed by a pair of bevel wheels to the shaft of the left-hand set of pulleys, through which the chain is driven, and as each share descends, it ploughs up a furrow. The locomotive mechanism is carried on the wheels, J, and its connection with the ploughing apparatus is such as to admit of the latter being adjusted to cut any required depth of furrow.

The locomotive portion is driven by a chain pulley on the crank-shaft, the endless chain from which works the pulley K; and the latter carries a toothed pinion gearing with a spur wheel fast on the main shaft L. On this shaft are the driving wheels, which, when the plough is at work, move in the direction of the arrow. When the machine is to be moved to a distance, it is driven by a second chain pulley, the chain from which goes directly over a pulley on the driving shaft, for the communication of a quick motion. Fig. 1 shows that there are three shares in the ground, ploughing three distinct furrows. To comprehend the action of the plough, we may suppose the distance from centre to centre of the bottom chain pulleys to be 20 feet, and the breadth of furrow to be 9 inches; then, in order that the shares may not interfere with each other, it is necessary, when the three furrows are cut at the same time, that the velocities of the ploughshares and locomotive be as 8.88 to 1. In other words, during the ploughing movement from C to C, the locomotive must advance 27 inches, which compound movement will produce furrows at an angle with the path of the plough. When one row of furrows is thus cut across the field, the machine is turned round to plough back again, so that the result is a series of zig-zag furrows. Instead of this angular ploughing, it is evident that, if one side is set 27 inches before the other, straight furrows across the entire field may be produced as at present.

The claim under both heads is general.

* These inventions are so utterly dissimilar, that we cannot possibly conceive how they came to be passed under one patent.—Ed. P. M. Journal.

REGISTERED DESIGNS.

TILE MACHINE.

Registered for Mr. W. Brodie, *Tile-Maker and Engineer, Airdrie.*

(*Illustrated by Plate* 54.)

Mr. Brodie's tile machine, the effective action of which we noticed in our June part, comprehends several valuable points of improvement, amongst which may be reckoned portability, the convenient arrangement of the gearing and the adjustment of the several shafts, and the arrangement for attaching the dies and clay screens to the clay boxes.

Fig 1 on plate 54, is a side elevation of the machine in its complete state; fig. 2 is a corresponding plan; and fig. 3 is a front elevation of the clay screen and dies, forming the end of the clay receivers or boxes. A, Is the first motion shaft, driven by the belt pulley, B, and carrying a fly-wheel, C, outside one of the standards, D D. The latter are cast in one piece with two supports, E, by which the machine is carried upon a pair of wheels, F, at one end—the other being supported on a standard, G, bolted on, for the single wheel, H, so as to render it easy of transport.

The driving shaft carries a spur pinion, I, gearing with the wheel, J, on the shaft, K, carrying a pinion, L, which again gears with the large spur-wheel, M, on the shaft, N. The latter also carries a pinion, O, which drives the large wheel, P, on the double-cranked shaft, Q Q. One of the arms, R, of the wheel, P, is cast very wide and deep, with a slot in it, to receive the arm, S, of one of the cranks, Q, which is sunk to the full depth of the wheel arm, and keyed in by wedges, T, so as to give additional strength to this part of the gearing, and save room in the width of the machine. This contrivance, which is a very important one, will be recognised by many of our readers as similar to that which has been adopted by many American engineers in fitting on the driving-wheels to the crank axles.

Each of the cranks, Q, has a connecting rod, U, for traversing the plungers or pistons, V, in their clay boxes, W. The ends of these boxes, as in fig. 3, are held in their places by the hook-bolts, X, the tails of which are passed through eyes at Y, in the cover of the boxes, whilst they are adjusted by wedges, Z, pressing against a notch on the under side of the bolts, the lower edge of the ends resting in a groove at *a*.

The back portion of the clay boxes is covered with a plate, *b*, broken away at *c*, for the purpose of showing the details beneath. The three shafts, A, K, and N, are fitted into solid metal bearings, *d*, turned eccentrically on their exterior, to fit suitable recesses bored out of the journal bosses, *e*, *f*, *g*, of the standards, D, so that, by a slight turn in either direction, these bearings will adjust the centres of the several shafts to the proper gear of the teeth of the wheels, being then secured from further motion by the set screws, *h*. The disengaging lever is at *i*. Its end, *j*, is forked, to fit a groove in the shaft, K, so that the latter may be traversed longitudinally in its bearings, to take the pinion, L, out of gear with the wheel, M; or, instead of sliding the shaft itself, a common sliding clutch may be adopted.

As delineated in our plate, the machine is cleaning clay in one box, and making pipe-tiles in the other; but these operations may be varied as circumstances may require. The extreme portability and convenience of this machine render it a most desirable addition to a tile manufactory, where, to save transport of the tiles, it is often necessary to work

Fig. 1.

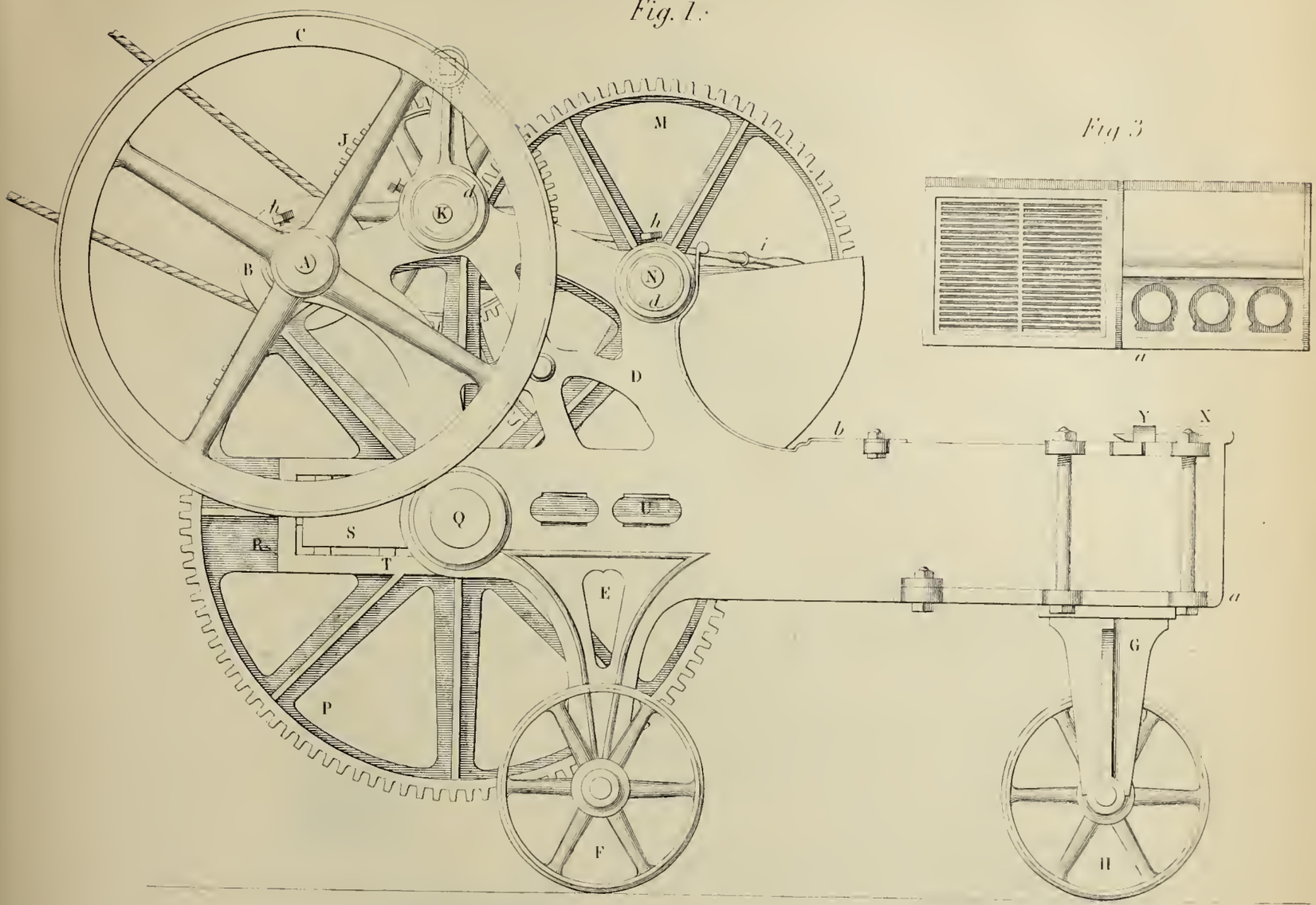
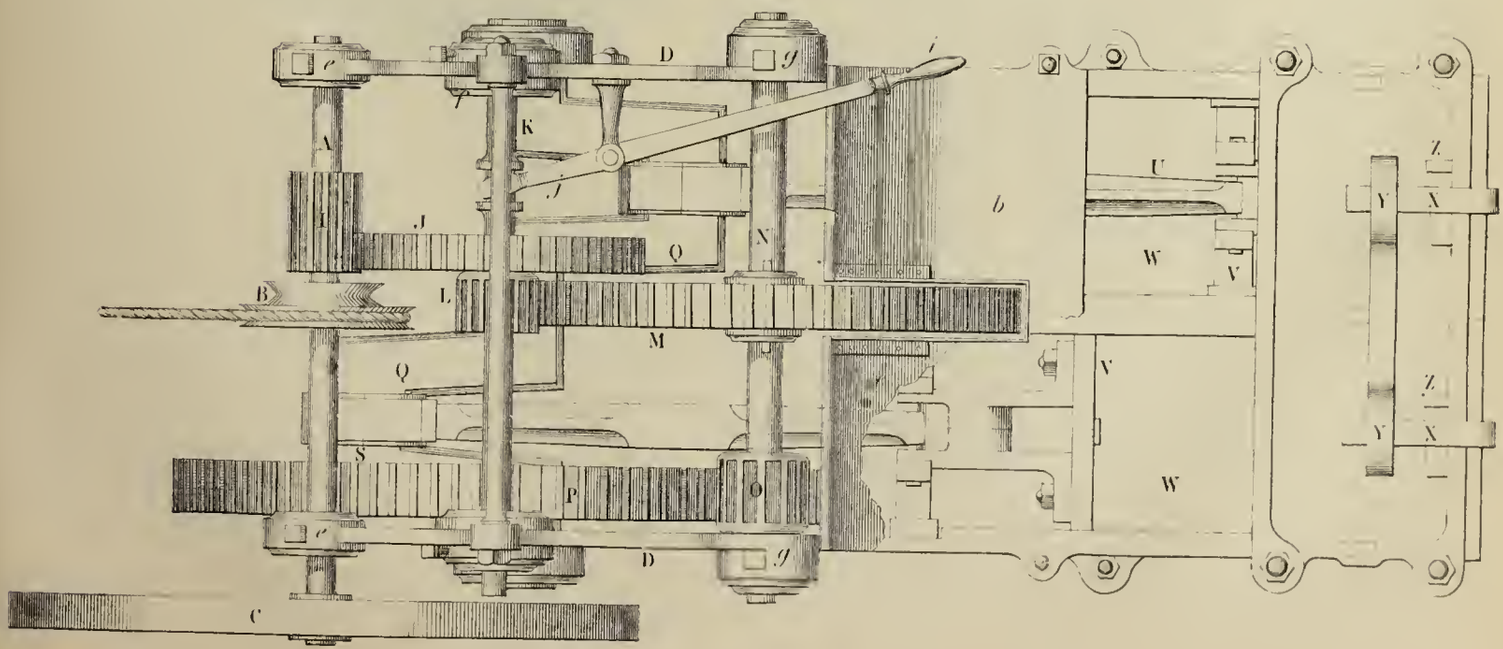


Fig 3

Fig. 2.



W. Jobnson
Patent Office Glasgow.

Mackay & Kirkwood Lith

Engd by Bisset Edinr.

the machine at a very considerable distance from the steam-engine. The example from which our drawings were made is driven by a light rope with ease, at a distance of thirty or forty yards from the power, the production being 16,000 2-inch pipe-tiles per day.

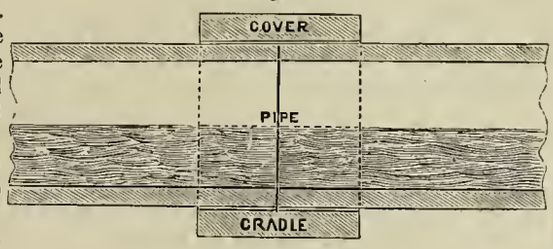
HERMETICAL JOINT FOR EARTHENWARE PIPES.

Registered for Messrs. A. Livingston & Son, *Portobello.*

The accompanying illustrations require very little in the way of explanation. They exhibit a very important improvement in the joining of tubular drain or water pipes, which the modern movement towards sanatory reform has called into existence.

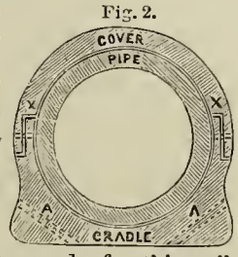
Fig. 1 is a longitudinal section of the ends of two pipes, showing the cradle and cover for effecting the joint. Fig. 2 is a transverse section through the joint, as surrounded with cement; and fig. 3 is a perspective view of the cradle, with one pipe laid in it, the cover being raised up.—

Fig. 1.



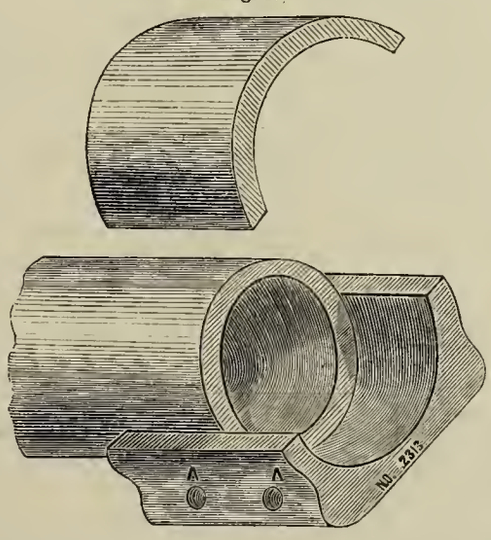
The holes marked, A A, are for passing wires through and under the cradle, when they may be brought together and twisted over the cover, so as to give a joint strong enough to stand a pressure of 1,000 feet. This arrangement will be found of great value for conveying water under pressure, as it furnishes the means of relinquishing the use of cast-iron and lead pipes.

Fig. 2.



Hitherto, the great leakage at the common spigot and faucet joint has acted very prejudicially upon the introduction of stoneware pipes. Messrs. Livingston's plan appears to offer an excellent remedy for this evil, as a great body of cement may be laid round the joint, and the full bearing adds solidity to the whole main pipe. Branch and offset pipes may also be easily joined up to a line with joints of this kind, as the cover, being lifted, affords ready access for the purpose. As leakage is entirely prevented by this joint, the objectionable effects of escaping sewerage are avoided. The internal surface is highly glazed, whilst the outside is left rough; and this roughened surface insures the adhesion of the cement, and hermetically seals the joint.

Fig. 3.

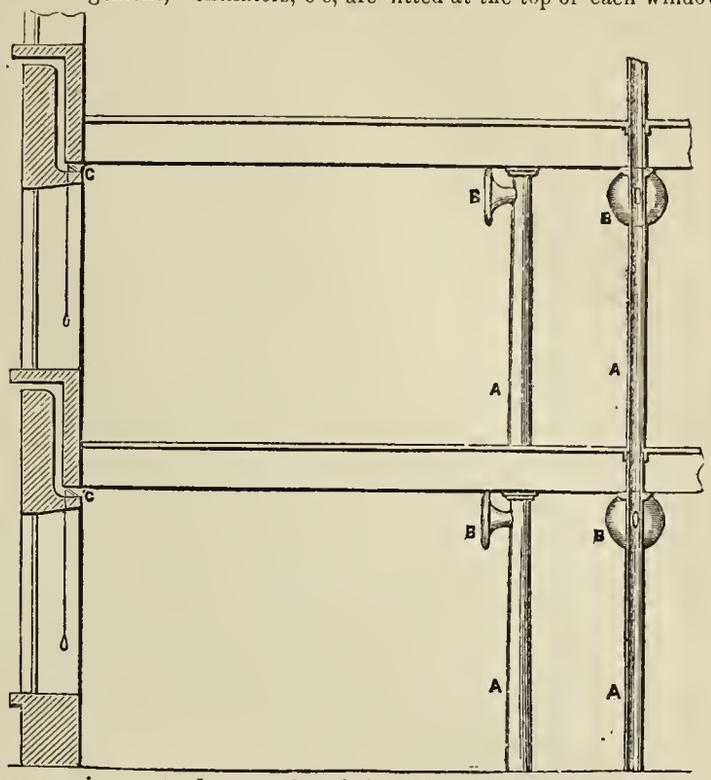


FACTORY VENTILATORS.

Registered for John Rowan & Sons, *Belfast.*

Most of the old class of our cotton factories present fine specimens of that utter disregard of ventilation which has done so much to ruin the health of the operative; but, in modern times, we find that the employer is sufficiently alive to his own interest, to see that the sanatory condition of his workmen has an intimate connection with his own well-being, and that to do justice to his business, he must also do justice to those who afford him the means of carrying it on.

In a mill now erecting at Millwater, Belfast, by Messrs. John Rowan & Sons, a novel plan of attaining the desirable object of pure ventilation is being put in practice. Our engraving exhibits a vertical section through the front wall and two floors of the factory, with the simple ventilating apparatus. The hollow pillars, or columns, A A, being set, as usual, one above another throughout the several stories of the building, are connected, the top of one with the bottom of the next, so as to produce a free passage through the entire series, from the ground-floor to the roof. The two columns in section show how this is done, by passing the top of each into the floor above. Near the top of each column an opening fitted with a trumpet-mouth, B, is made, and in this way the vitiated air is collected and carried off at the top of the building. In addition to this arrangement, ventilators, C C, are fitted at the top of each window.



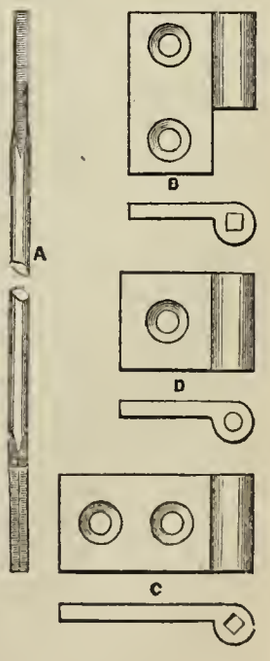
These openings extend across the whole width of the windows, and may be adjusted by pendant cords hanging down in front of the windows. The external communication of these openings is by passages formed in the wall, and passing upwards, so as to discharge beneath the sill of the next story.

In the same erection a new feature of construction has been introduced, in the dispensing with bonding-timber, iron bars, 2½ inches by ⅝ inches thick, being substituted instead. These bars extend from pier to pier in each story, forming a stout hoop round the building, and binding the whole fabric together.

DOOR SPRING.

Registered for L. R. Bodmer, Esq., *Manchester.*

This elegant little contrivance is a very decided improvement in self-acting door-closing apparatus, the different varieties of which embrace so many cumbrous, expensive, and complex arrangements. Our figures give the spring mechanism—if we may dignify so simple a plan by the name—in detail, and detached from the door.



The spring-power is entirely derived from the torsional strain on the vertical piece of tempered steel-wire, A, represented as broken in the middle. The ends of this spring are squared to fit the square holes in the eyes of the brackets, B C, whilst the main portion is round, and fits a corresponding eye in the central guide, D. Each of these figures is shown in elevation and plan: they resemble ordinary hinges. To fix the spring, so as to get the required torsional action, the bracket, B, is first attached to the door-post, so that the centre of its socket shall be in a line with the centre of movement of the door-hinges; the upper end of the spring is then temporarily inserted in the eye of this bracket, when the bottom bracket, C, is placed on the lower end of the spring, and its position on the door is marked out. The guide, D, is then screwed to the door-post; the upper end of the spring is again inserted in the bracket, B, and the bottom bracket is then once more placed in its position. The proper amount of torsion —varying from one-eight to one-half of a revolution—is then given to the spring by turning the lower end on which the bracket, C, is fixed in the direction of the opening of the door, when the bracket, C, is finally screwed to the door. Thus the bracket, B, and guide, D,

are both fast on the door-post, whilst the lower bracket, c, is on the door itself—the whole three having the centres of their eyes in a line with the centres of the hinges. As the door opens, the torsion upon the wire increases, and on being let go, it will be again closed with a force proportioned to the torsion given. The spring-wire may either be made to extend from the upper to the lower hinge, or it may be shorter, if required.

REVIEWS OF NEW BOOKS.

Treatise on Marine and Naval Architecture, or Theory and Practice blended in Ship-building. By John W. Griffiths, Marine and Naval Architect. Quarto. Plates. New York: Published by the Author. London: Putnam's American Agency. 1850.

The appearance of this American serial, devoted to the art which is so well understood on the other side of the Atlantic, will be welcomed by the British ship-builder as a most important addition to his library; whilst it will be felt as a sarcasm upon that backwardness which has left us—a maritime people—indebted to a foreign source for the only modern work of the kind, of solid pretensions, which we possess. Why this is so, would be difficult to guess, unless we accept in explanation the old established fact of the extreme unwillingness of our genuine practicians to venture into the labyrinths of authorship, either from lack of time, diffidence of their literary powers, or a narrow and hastily formed resolution of keeping their experiences to themselves. The first of these is probably nearest the mark—for the actively employed professional man can seldom snatch any available time from his avocations, or lay down his working tools—whether the compasses or the hammer, to take up the pen. Mr. Griffiths is a brilliant exception—but then he is an American, and "goes a-head."

In his introductory notice, he says—

"In this age of unparalleled progress, the advantages of a work on this science are scarcely less obvious than charts to the mariner who navigates a dangerous coast. The author is aware of the responsibility that must rest upon the man who shall introduce an American work upon this subject; but while he is conscious of the magnitude of the work before him, he takes the helm with the fullest assurance that the Argus-eyed genius of American mechanics will mete out to him that justice the work itself demands. He proposes to publish a clear and analytical work on ship-building, embracing all that is known to be of practical utility both in the Old and New World, together with such improvements as have been introduced by himself, and which, from demonstrable evidence, have ceased to be problematic. And while he thus extends his mechanical chart beyond the path his fathers trod, and introduces the connecting link between theory and practice in this complicated art, he ventures to cherish the hope that he will receive the same amount of patronage from the mechanics of the United States that has been extended to foreign authors."

From this statement our readers may gather what he has proposed to himself to accomplish; how far he has succeeded, we shall endeavour to show from the eight parts now before us. Let us see how he opens his "early history of ship-building:"—

"No leaf from the pages of antiquity can contribute so much towards endowing posterity with a correct knowledge of the race of man, as that which narrates the progress of science and art. As no descriptive exhibitions of the tree equals that of its fruit, so no expositions of the workings of mind so fully develope the capacities of the inner and the outer man, as the work of his hands. In scanning the musty folios of the past, it would seem that a second deluge had swept every page of the history of mechanical science from the face of the earth. Our reductive energies are shackled by historians, who have delighted to luxuriate on the rise, progress, and ruin of their race, while the most prolific mines of science and art have been left unexplored; the most valuable discoveries to the commercial world have been consigned to the incendiary's torch, or doomed to the tomb of the Capulets; the exuberance of language has been exhausted to laud the hero, and foster a spirit of military glory; the bloody riots of butchers of their race, and the desolating march of tyrants, have been narrated with redundant effusion. The irretrievable loss of information respecting the prominent mechanics of early ages, may be attributed to the unsophisticated dogmas of such men as Plato, who poured out ebullitions of wrath against his followers for debasing the excellence of geometry, by applying it to sensible things. Thus, the waves of oblivion cover the crumbling temple and its builder in the same solitary grave. The baleful shadows of the past become thick and impenetrable, like the midnight of Egypt; the fluctuous tide of time leaves only the mound between the furrows on its shore, to mark the spot where nations sleep. Alas! this unsparing scythe has swept over the glories of the past, and thus we read the fate of the present. The lover of antiquarian knowledge strains his eager vision in poring over the musty pages of the past—he looks in vain to find anything calculated to make him wiser, surviving the wreck of time. The philosopher sighs and mourns over the desolation. The man of science weeps as he looks at the almost universal blank. The agriculturist is palsied in amazement at the silence that everywhere reigns, on the subject of sustaining animal life. The mechanic is led to exclaim: If the past can furnish no wholesome admonitions for the future, let it perish from the recollection for ever; let the mantle of oblivious drapery cover its crumbling pyramids and solitary graves! It is nothing to know what our ancestors were, unless it be accompanied with the desire to emulate their virtues and avoid their errors. What, though the mildew of mythology covers the past; and like the simoom of the desert, commissioned to obliterate all impressions, and leave one wide-spreading waste! But our Creator has, in benevolence, as in wisdom, adapted our mental constitutions to our moral responsibilities, and permitted us to weave the rainbow of anticipation on the dark rolling clouds that overshadow the past. How willingly, when thus illumined, do we recur to periods of bygone greatness, and throw ourselves on the bosom of the tempestuous wave, feeling at ease amid boisterous commotion, as one relic leads to the remembrance of another. It is thus associations become, in our hand, a golden chain, the links of which lead us through the misty labyrinths of commingling thought, to the birthplace of their existence. Whenever we attempt to penetrate the veil of obscurity, that mantles from our view the work of ancient mechanics, we are led to regret that some one of their number did not, for the sake of posterity, undertake to give a graphic description of the state of mechanical science. Many learned men of old deemed it the part of wisdom to conceal in mysticism all discoveries in science. This custom was so prevalent at one time, that philosophers refused to leave anything in writing explaining their researches. How vast the change! The world, in modern times, would give more to witness the evolutions of the Athenian shipyard, than to witness the battles of all the marshalled armies of their race."

This is rather fine writing, and smacks little of the ship-builder; but he settles down as he approaches the business of his task. He lays great stress, and rightly, upon the American plan of constructing miniature models for laying down a ship's lines. To the pages treating on this subject we may at once refer the enquirer for some sound practical information.

The eighth part ends in the sixth chapter, and completes half the book. The remaining chapters promise much important matter, which will demand our examination as the outline already laid down is filled in. The appearance and general "getting up" of the work is an improvement upon the ordinary run of American books. It is printed on large-sized fine paper, but in a type, to our taste, almost twice too large. The illustrations are copious, and accurately drawn; the style being one well suited for the wide spread line-work in ship's draughts—white lines on a black ground.

Drawing from Objects, being an Abstract of Lessons given at the Home and Colonial Training Schools. By Hannah Bolton. London: Groombridge & Sons, 5 Paternoster Row. 8vo. pp. 130. Plates and Woodcuts. 1850.

As a "hand-book for beginners," which the authoress of "Drawing from Objects" modestly designates it, this volume deserves our best commendations for its pointed adherence to simplicity, and the avoidance of technicalities beyond the reach of those whom it is meant to assist. It is founded on the French system of drawing from geometrical forms—now so much in favour in this country—and in which the writer has had a six years' experience, with about 2,000 pupils. For general instruction in drawing, it is a matter for question as to whether or not geometrical forms should be selected in preference to the natural every-day objects of domestic life; but, setting this aside, there can be but one opinion on the success of this exposition of the former system.

It is divided into seven chapters, treating of "Definitions—Explanation of principles, relative to the apparent alteration of forms rectilinear—Application of principles, consisting of equal exercises—Triangles—Quadrilateral figures—Curvilinear forms, and their apparent alterations—and Grouping, or arrangement."

In commenting upon drawing in relation to trade, in the introduction, reference is made to the statements brought out before the Select Committee on Designs in 1836.

"The Report of the Committee gives the following among other evidence of the deficiency in England of taste and artistic skill.

"James Morrison, Esq., M.P., of the firm of Morrison and Co., says—'I have been well acquainted with the manufacturers of this country for more than twenty years. I have found, generally, that we have been very much superior to foreign countries in the general manufacture, but greatly inferior in the arts of design. The great mass of the community in this country, not merely the lower and middling classes, but a great portion of the upper classes, have not had their taste cultivated in proportion to their education.'

"Mr. J. Smith, of the firm of Harding, Smith, and Co., Pall Mall, says:—'There are many articles we are importing from France, which, were we in possession of designs, might be equally well manufactured here. I do not think a French article would sell, without reference to its particular merit.'

"A gentleman connected with another house at the West end was asked, 'To what circumstance do you attribute the superiority of France in the manufacture of gloves?' 'To the knowledge the manufacturer has of the shape of the hand,' was the reply. Every manufacturer can draw the hand, before he presumes to make a glove to fit it; the reverse is the case here. The hand is convex outwardly, and concave inwardly; no man is aware of this who does not study its shape. Foreigners esteem a practical acquaintance with the art of drawing indispensable to success in business. In every trade, manufacture, or profession, the porte-crayon or the pencil is called into requisition.

"The ignorance of English operatives, in connexion with diagrams and pictorial illustrations, will be acknowledged by every one who, through their agency, has attempted to convey an idea of the form of a given object. Show a carpenter a corner view of a stool, and he will say with the utmost gravity, 'But are the legs to be all of different lengths?' A question as provoking as the obligation to pay for an article made after such fashion. Neither can masters, with few exceptions, skilfully sketch out plans and figures required by their workmen. Hence arise in business needless expenses and unnecessary delays."

Although we have not stood quite still for the last fourteen years, yet a good deal that was said of 1836, will apply equally well to 1850, and the youthful student of the latter date will not find his time thrown away which he devotes to "Drawing from Objects."

The Manufacture of Iron, in all its Various Branches. By Frederick Overman, Mining Engineer. 8vo. Pp. 492. Woodcuts. London: G. P. Putnam, 49 Bow Lane, Cheapside. Philadelphia: Henry C. Baird. 1850.

This is another practical American work, which, curiously enough, falls to be reviewed alongside Mr. Griffiths' able production, from the same side of the Atlantic. What we have already said as to our want

of a modern home-grown work for the marine architect, applies, perhaps, in still stronger force in the relation of this volume to the practical iron maker of this country. It is true that there are many differences between the English and American systems of procedure; but, in the execution of his task, Mr. Overman has been careful to expand his subject sufficiently, to give his volume a clear application to all known processes, however varied by fuel or locality. He has divided his remarks into the heads of "Ore, Fuel, Reviving of Iron, Manufacture of Wrought-iron, Forging and Rolling, Blast Machines, Hot Blast, Waste Heat and Gas, Fire-brick and Refractory Stones, Motive Power, and the Manufacture of Steel." In the early portion of the volume, relating more expressly to the manufacture of crude pig-iron, although there is much that the young practitioner will find most valuable matter for reference, there are yet many observations at which his older fellow-labourer will smile and shake his head. Our position as makers of pig-iron is in the first rank—not so as producers of wrought-iron and steel; and for this very sufficient reason, the latter portion of the volume most deserves our examination. We will select an introductory example from his chapter on "puddling:"—

"Our own experience, which is somewhat extensive in this branch of the business, proves that white metal from the richest ores is unfit to be worked at all in a furnace with a cooled heartb; and produces far better iron in brick linings. Pig-iron from small burden and coke, we never succeeded in improving. With white iron from charcoal furnaces and small burden, we were equally unsuccessful. The most favourable pig-iron is that which is made by a small quantity of coal and by low temperature in the blast furnace. The lower the temperature the better the iron. Pig-iron smelted from phosphates, is easily converted into the best kind of bar-iron, if the temperature of the furnace has been low, or the burden heavy; but if smelted from the same ore, and by a high heat, whether charcoal, anthracite, or coke, it is improved with difficulty; sometimes total failure results. The same rule is applicable to pig-iron smelted from silicious and sulphureous ore. In fact, it may be laid down as a general rule, that the smaller the amount of coal consumed, or the lower the temperature of the hearth in the blast furnace, the better will be the quality of the metal; that is, the more fit it will become for improvement in the puddling furnace. We thus see the advantage of heavy burden in the blast furnace, for it not only reduces the first cost of the metal, but makes a far superior article for subsequent operations. We may safely say, that the worst cold-short or sulphureous metal, smelted by a low heat, is quite as good as the best metal from the best ore smelted by a high temperature. We will give a practical illustration.

"About ten years ago we were engaged in improving cold-short iron; that is, pig-iron smelted from bog ore, which, before that time, possessed no value whatever. Our manipulations were conducted in a double furnace, with water boshes. The puddling was carried on by means of artificial fluxes. We succeeded, without difficulty, in producing a beautiful bar-iron, in quality equal to the best in the market. With the object of testing its virtues, a portion of it was sent to a distant mill, and converted into wire. So successful was the result, that the puddled iron was preferred to the best charcoal iron. At the wire mills, where an extensive business was done, a large quantity of charcoal iron was needed. As this could not be obtained in consequence of its expensiveness, puddling works were erected for the purpose of furnishing iron for the inferior qualities of wire. At this establishment, steel metal of the most superior kind was wrought, which, of course, puddled in single furnaces, with good fire-brick lining, made an excellent bar-iron. After using the iron of our cold-short metal, the owners of the rolling mill entered into an engagement with us, by which we bound ourselves to furnish as good an article from their superior plate metal as we had made from worthless phosphorous pig. A few heats made in one of their own puddling furnaces indicated that improvement was possible; but, owing to certain peculiarities of the new process, puddling could not be performed in a brick lining. We therefore concluded to erect a double furnace at once, and apply iron boshes. Until that time, our practice had been confined principally to the worst kind of pig-iron, and accompanied with more or less success, according to the nature of the metal with which we had to deal. We entered upon the undertaking with great confidence. The idea of failure never entered our mind. This confidence appeared to be justified on account of the insignificance of the improvement required, compared to what we had already arrived at. The metal was the best which the continent of Europe afforded; but, after all our exertions, the ultimate result was a total failure. As this is one of the most remarkable as well as interesting cases which ever happened, we shall relate it somewhat in detail, which may serve a useful purpose. The metal used was smelted from sparry carbonates; it was almost crude steel, that is, white metal containing carbon in large amount. Being thoroughly acquainted with the most important part of the operation, we took great care to have a furnace of good heating capacity. The metal melted in a short time, at a low temperature; but the least stirring with the tools made it crystallize, and worked it into nature; and sufficient time was not left to enable us to mix it properly with the cinder. The result was a dry hard iron, which broke under the hammer. No effort was left untried to overcome this apparently trifling difficulty; and when we at last succeeded, a very singular circumstance put a stop to the experiments. The breaking of the balls under the hammer is, in all cases, the result of too slow work. The workmen did their best; but the iron worked too fast. This is generally the case with white iron containing a great deal of carbon. The application of fluxes retarded the process. At last the metal worked well, and became soft and tenacious iron. But, when piled and reheated, a number of the bars broke in the merchant rollers; and the iron, commonly of a silvery white appearance, exhibited in its fibres a dark colour. On a second reheating, both in a blacksmith's fire and the reheating furnace, it broke up into small fragments. In fact, it was iron no longer, but black magnetic oxide. Rolled down to two half inch rods, it broke into fragments on the first heat. Bars one and two inches square, exhibited on their surface a high degree of oxidation, and appeared, internally, of a fibrous, dull yellowish colour. On the application of the slightest heat, this colour changed to black.

"The above experiment is a highly interesting one. It shows clearly the legitimate scope of improvements, and the direction in which experiments should tend. The metal employed was, as we have stated, of the best quality. It furnished excellent steel with the greatest facility. In the charcoal forge, it furnished the strongest kind of bar-iron—consuming per ton of iron only from 110 to 130 bushels of charcoal. In the single puddling furnace, with brick lining, it produced a firm, tenacious iron, but of too coarse a fibre, and containing too much cinder for the manufacture of wire; while, in the puddling furnace with iron boshes, it did not work at all, and ultimately returned to its primitive condition—that is, became oxidized to ore."

The various processes of forging and rolling, and steel-making, are minutely treated, and admirably illustrated. We must return to the book again—satisfied in the meantime with introducing it, although thus briefly—as the best practical assistant which the modern iron-maker can place on the shelves of his library.

CORRESPONDENCE.

WHITELAW'S STEAM-ENGINE EXPANSION GEAR.

In the May number* of the "*Practical Mechanic's Journal*," we find an illustrated article under this title, upon which we have to make a few remarks. It is there stated that the arrangement in question was originally published in 1834; but until the appearance of the article referred to, neither ourselves, nor the patentee of our expansion apparatus, were aware that any such publication had been made. We have examined the Repertory of Patent Inventions for 1835, to which we have been referred, and there we certainly find some parts, described by Mr. Whitelaw, having some similarity to parts of our arrangements for effecting the same purpose. Mr. Whitelaw saw the desirableness of a variable and self-regulating expansion gear, and in his communication has made some good suggestions on the subject, which, however, for some reason or other, he has never reduced to practice. His letter, bearing date Nov. 1834, concludes as follows:—"By a trifling modification of the gearing for working the valves, the plans given in this letter may be applied to almost every form of the steam-engine." Had this proved correct, almost every steam-engine in the kingdom ought before this time to have had his plans applied, yet we have not heard of its application, in a single instance.

We trust we should be ashamed to detract from the well-earned fame of any person, but we have two complaints to make against the article in your *Journal*. First—It professes to give "complete drawings, with full details," of Mr. Whitelaw's communication of 1834. This is not done, and any person who understands the subject will easily find great discrepancies, which we need not now describe.

Second—In the last paragraph of the article, the assertion is made that for Whitelaw's "very contrivance," fully explained at the early date assigned to it, "an engine-builder in the neighbourhood of Manchester has, even in late years, succeeded in obtaining £1 per horse power, in the shape of Royalty, for all engines erected by him with the same arrangement."

This paragraph is, doubtless, aimed at our "patent variable expansion apparatus," which is already applied, with the greatest success, to scores of engines, and the number is constantly increasing. We do not know who could furnish you with information sufficient to induce the insertion of this remark; but we do know that a competing engine-builder from a neighbouring town carries the *Practical Mechanic's Journal* for May in his pocket, to endeavour to persuade parties who may be in want of steam-engines, that "Petrie's Patent" is not a valid one. As, however, a periodical is not the place to determine the validity of a patent, we will, at present, only remark, that if you had had an opportunity of examining our apparatus at work, your knowledge of the steam-engine, and of the patent laws, would have prevented you from publishing the incorrect statement of which we complain, and would have enabled you to state that the steam-engine with our improvement is the most economical, self-regulating, and perfect of any ever produced.

JOHN PETRIE & Co.

Rochdale, July, 1850.

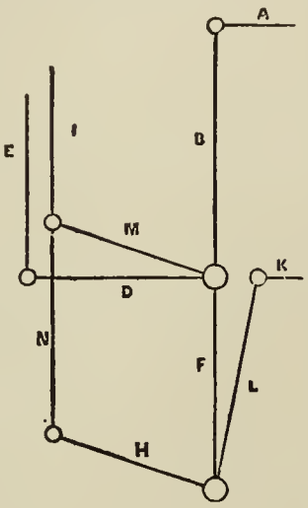
The whole tenor of Messrs. Petrie's communication amounts to a charge of neglect of our editorial duty, in the publication of the remarks on the originality of Mr. Whitelaw's invention. Without stopping to investigate Messrs. Petrie's reasons for applying the case to themselves, let us see how the accusation stands with the evidence which has been forced upon us.

Mr. Whitelaw's plan had been three times published previous to our notice of it, and the article in the May number had the twofold object of bringing forward a most ingenious arrangement, and advancing the real inventor's claim to originality. Whoever has perused this article, must have felt with Messrs. Petrie, that Mr. Whitelaw did see "the desirableness of a variable and self-regulating expansion gear," and that he "made some good suggestions on the subject; but it is probable that the inquirer will not sit down satisfied that these said suggestions have never been carried into effect, seeing that the plan has been extensively introduced by London engineers, the only difference being that an eccentric was employed for cutting off instead of a cam, the modification being anything but an improvement, whilst it was not self-regulating. As we have been referred to Messrs. Petrie's subsequent patent, it is desirable that we should know in what respect their plan is an improvement upon the original. Our article gave what it professes to do—an exact account of the expansion apparatus. The first account given in the Repertory of 1835, is rather more complete than the one given in appen-

* Page 28.

dix, B, to Tredgold, in 1840; and if Messrs. Petrie will take the trouble to refer to the latter work, they will see that our figures, 1, 2, and 5, at page 29, are faesimiles of Tredgold's illustrations.

In the Repertory the governor action is given; in Tredgold it is not; and in the former the arrangement of the levers and spindles for the cut-off is the better of the two. The annexed diagram shows the plan. A, is the eccentric rod working the lever, B, on the rocking shaft, C; D is a lever, and E a side-rod communicating motion to the cross-head that works the large, D, valve. F is one of the two levers in which the spindle, G, works; H is one of the two levers, and I one of the side rods which actuate the cross-head of the cut-off valve. K is the rod worked by the cam, and L the lever worked by this rod. M is a lever, or rather something similar to a radius bar, one end of which works loosely on the rocking-shaft, C, whilst its other end is jointed to, and connected by means of, a round pin to the rods I and N. This description, taken in connection with the particulars given in our number for May, will, we think, be quite clear.



Messrs. Petrie rightly state that "a periodical is not the place to determine the validity of a patent," nor if it were, could we spare either time to investigate how far Mr. Whitelaw's plan bears upon theirs, or space for the record of our opinion thereon. If there is any collision, the public will speedily find it out—if there is none, we conceive Messrs. Petrie will rest satisfied with being in the right.

Our readers will, we think, exonerate us from the necessity of disclaiming any connection with the "competing engineer" who does us the honour of carrying "the *Journal* for May in his pocket," for the very peculiar purpose mentioned by Messrs. Petrie, and they will perhaps further credit us for the "fidelity in copying," and accuracy of remark, with the lack of which we have been so unceremoniously charged.—Ed. P. M. Journal.]

RUTHVEN'S STEAM-SHIP PROPELLER.

I may repeat that I have no intention of "chopping up science for the million." I may repeat also that, in my last letter, I wished "merely to remove some of the grosser misconceptions, which appear largely to prevail, of the nature of the power derivable by effluent water."

To be brief, I shall notice your propositions seriatim:—

1st. I rave about the term 'reaction,' because an accurate definition is half the argument. To those who are acquainted with the history of human reason, it is superfluous to say that a very large proportion of all controversy is traceable to the misinterpretation of language, or the misunderstanding of words.

2d. My "tall vessel," which is, in truth, not mine, but borrowed from the pages of the Practical Mechanic and Engineer's Magazine, was introduced to show where the power lay. You agree with me that the power originates *within* the nozzle or ajutage—that it is unbalanced pressure inside the machine. It was nothing to me, for the object with which I ostensibly penned my last letter, what amount of pressure was called into action on the withdrawal of the plug. It was locality, Sir, and not quantity, with which I interested my disciples on that occasion. Your lucid explanation of the origin of the double pressure is but a repetition from those celebrated pages from which I likewise have been inspired.

3d. I do not perceive the force of your reflection on the poor monosyllable 'jet.' I may refer you to my first remarks on the propriety of exact definitions, to show how improper it is to strain the meaning of words. You are, or ought to be, aware, that the theoretic perfection of the method of effluent water for obtaining power, consists in the equality of the velocity with which the water leaves the orifice, to that with which the nozzle advances, when the water, of course, simply drops from the machine. It is to this perfect idea, that water-engineers seek to approximate the conditions of their machines, and though it may be, and is, expedient to expel the water at a speed of 15 to 25 per cent. above that which corresponds to the idea, for the sake of the increased accommodation so gained,—I speak in reference to marine propulsion,—and though, also, some increase of propelling force is so acquired, much of the extra power of the water is forfeited. Now, mark me, the extra velocity communicated to the water is not imposed for the sake of power, but for the sake of convenience. In proportion, then, as the speed of the effluent water, in reference to the vessel, can be approximated to the speed of the vessel in reference to the water in which it floats, the approximation to the central idea of the power of effluent water is to be measured.

4th. With regard to the area of the orifice suitable for a 500 horse power steamer, moving at the rate of 16 miles per hour, if I understand you rightly, you suppose it to be a closer. You have, obviously, with all your humility, never performed the calculation—granting your ability to do so. Your insinuations respecting the ratio of the area of the orifice to the immersed cross section of the boat, if they mean anything, imply your impression that the ratio is that of 1 to 1. Verily, the ship would, under such a necessity, be scuttled with your precious jets. I shall relieve your anxiety by informing you, that, agreeably to the condition of equal velocities imposed by yourself, the area of each "jet," of which I suppose there are two, would not exceed one-fiftieth of that of the immersed cross section. Although, therefore, I have not said that you do not understand the subject of your criticism, I have, in the politest manner imaginable, proved that you do not.

5th. As to the gentleman named by you, in connection with the foregoing troublesome problem—the author of a work on arithmetic, I believe—I do not know him, though I have frequently seen his name introduced when jokelets are substituted for wit: I consider him an ill-used man. I have to thank you for suggesting the use of a slate; but, my dear Sir, I did not require it, I usually perform my calculations of a transitory character on the blank spaces of a magazine, in which I frequently find blanks where there may be plenty of print.

6th. The propeller schemed by Bodmer, which you confidently aver I have not seen—as if you and I were inseparable twins, which we certainly are not—is, I repeat, as diverse from Ruthven's plan as the ordinary paddle is. When you prove a contrary, in some other mode than by alluding to good reasons, I may "let myself down" to further particulars.

7th. As it appears that it is expedient to cause the water to issue from the orifice with a speed greater, to some definable extent, than that designed for the boat, it is, of course, preferable to discharge the water above the water-line, inasmuch as the medium into which the water is discharged offers, according to its density, a resistance to its exit. And while you state that it would be preferable in practice to discharge below the water-line, not so said the pages of the Magazine before mentioned. If you will turn to page 63 of the volume for 1846, you will find that the writer congratulates himself on having persuaded the Ruthvens to discharge above the water-line, though probably they never saw or heard of his previous suggestions, and their practice has never been otherwise.

There is nothing more of importance in your remarks. I am glad you consider my crop of science to be in an improving condition, though I do not know how you formed the conclusion; and, flattered by your approbation, I may favour my disciples with another mess, and on very short notice.

D. K. C.

July, 1850.

[Our eccentric correspondent has twice told us that he has "no intention of chopping up science for the million," and emphatically backs his statement by filling up the greater part of two of our pages with the cuttings which he has disowned. He asserts his brevity, whilst he indulges in a long string of pointless sentences, which leave the matter where he found it.

We cannot but feel for his unfortunate choice of a magazine, containing so many blanks, that he is obliged to use up the paper by making his calculations upon them. The only remedy we can suggest, is the substitution of a *Journal* for the useless work. His "brevity" compels us to shorten our remarks; but, before parting, we may suggest, that in future he should confine his assertions to such points as he is able to substantiate. When he really can prove our inability to cope with any subject which he brings before us, in some other fashion than what he has termed the "politest manner imaginable," and when, in addition, he can oppose our arguments by something better than the mere reference to a single isolated opinion of somebody else—the truth of which is established by the fact of its being in print—we may attend to what he has got to say.—Ed. P. M. Journal.]

DISCONNECTING APPARATUS FOR PADDLE-WHEELS.

I enclose a sketch of a scheme for the disconnecting gear of paddle-wheel steamers, and I will, with your permission, make a few remarks on the plans at present in use, before proceeding to describe my own.

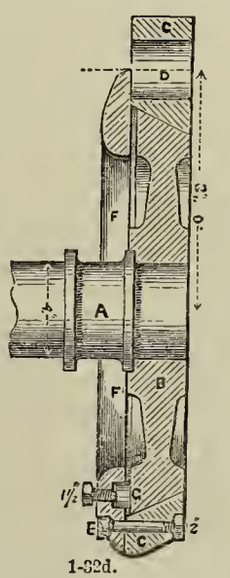
It is a pre-requisite in any plan for disconnecting, in order that the connection may be made again, under any circumstance, with safety, that

the wheel should be left free while the connection is being made, as in a seaway it is often very difficult and dangerous to attempt to hold it fast in one position. In Maudslay's, Seaward's, and Grantham's plans, the wheel must be brought round to a certain point, and held there during the connection, not a quarter of an inch play being allowed, and consequently these schemes are nearly valueless. The only one as yet in use that is free from this objection is Braithwaite's, consisting of a disc and friction strap, with a block, which is tightened up by a large cutter, and with this the majority of our vessels are fitted. There are, however, several practical objections to this plan, partly arising from the manner in which it has been fitted; one is, that in order to reduce the friction due to the weight of the strap when running disconnected, it has been lined with brass, the disc being cast-iron. The effect has been to reduce the friction when it was not desired, viz., when connected, so much so as to give a great deal of trouble in getting it to hold.

Another evil is the immense weight of the cutter; in one case, of only 370 horse power, it is 90 lbs., and therefore requires a proportionately heavy and awkward ram to drive it; and the difficulty of directing this ram in its fall from a height of 8 or 10 feet, when the ship is in a heavy sea, may be easily imagined. It is true this evil has been partly obviated by the substitution of two lighter cutters for the one heavy one, which, by the way, had a round back to increase the difficulty of driving it; but this only half meets the objection.

I am aware that modifications of Braithwaite's plan have been proposed in your pages, but, as well as I remember, they are all too complicated and encumbered with toothed wheels, &c., to be of real use.

In the accompanying sketch, A represents the paddle-shaft, B a disc keyed on it in the same manner as Braithwaite's, the edge being turned conical to a taper, sufficient to insure its not sticking to the hoop, C, which is bored to fit it. This hoop has an eye, D, at one side, to receive the end of the crank-pin. The hoop is a little thicker than the disc, as shown, and on the back of it is bolted by the bolts, E, another hoop, F. At intervals of 10 inches, the inner side of F is bored out to receive small blocks of steel, G, 4 inches diameter, and each provided with a pinching screw with a hardened point, and six-pinned head for a spanner. It is by these screws that the hoop is drawn on to the cone of the disc, until it holds by friction. When it is wished to disconnect, the bolts are slacked back, and a single blow of a sledge will suffice to separate the cones.



1-32d.

The advantages claimed for this arrangement are, that from the screws which are employed to produce friction, being of a manageable size, and made of steel, there will never be any danger of their sticking fast, or of any part getting bedded into its place by the strain, as happens to the cutters in Braithwaite's plan; there are no unwieldy rams or other large tools required, and the adhesion of the strap, when connected, will be far greater than with a cylindrical disc.

The working of the arrangement is perfectly independent of the motion of the wheel.

ENGINEER, R.N.

July, 1850.

ON CALCULATING CHANGE WHEELS FOR SCREW-CUTTING.

I am anxious to obtain some practical information on the subject of screw-cutting in the lathe, and should feel very greatly obliged if you could supply me, through the *Practical Mechanic's Journal*, with some particulars as regards making the necessary calculations for the change wheels to be used for this purpose.

A WORKING MECHANIC.

Newcastle-on-Tyne, *July*, 1850.

[In assisting "A Working Mechanic" in the way he mentions, we do so only upon the presumption that practical information of this kind in a tabulated form will be found very generally useful to men of his class, when placed in a position so accessible as the present page.

As every lathe-maker arranges his gearing according to his own notions, it will be unnecessary to remark upon these details, as the following statement is equally applicable in all cases. We will suppose the leading or guide screw to have two threads to the inch—or half-inch pitch—and copies of 8, 3, 2, and 1 threads per inch are required. Under these conditions, then, the teeth in the wheel on the mandrel, and that on the guide-screw, must bear to each other the proportions of the fractions $\frac{2}{8}$, $\frac{2}{3}$, $\frac{2}{2}$, $\frac{2}{1}$, the guide wheel being the constant numerator. Any multiples of these fractions may be selected for the change wheels to be used, as all multiples of $\frac{2}{8}$, as $\frac{4}{16}$, will produce a screw of 8 threads to the inch—the finest of the group we have named. Here we have assumed that the wheel on the mandrel gears direct with that on the guide-screw; but screws 2, 4, or 6 times as fine may be obtained by interposing a second pair of wheels, respectively multiples of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{6}$, and placed on one axis.

The value of any combination of wheels may be obtained at once, as vulgar fractions, by multiplying together all the driving wheels as numerators, and all the driven wheels as denominators, adding also the pitch or fractional value of the guide-screw. Thus:

$$\frac{30}{40} \times \frac{20}{48} \times \frac{1}{2} = \frac{600}{3840} = \frac{1}{6\frac{1}{4}} \text{ of an inch, pitch of screw.}$$

Here wheel 30 on mandrel drives the carrier 40, and the stud of the latter carries wheel 20, which drives wheel 48 on guide-screw.

An extremely useful table has been compiled by Mr. Whitworth, showing the trains of wheels for cutting screws, varyiug in pitch from 1 to 70 threads to the inch. The leading screw has two threads to the inch, but the table may be employed for screws with 4 threads, as the same train of wheels would suit for cutting screws of double fineness; and with a screw of one inch pitch, a screw of one-half the fineness will be given with any train on the table.

It will be observed that, in the first column, the wheel and pinion carried by the intermediate stud, and forming the means of communication between the mandrel and guide-screw wheels, are omitted, as they are not required in cutting screws of the pitch there given, a simple carrier being substituted for them.—ED. P. M. JOURNAL.]

No. of threads per inch of screw.	No. of teeth on		No. of threads per inch of screw.	No. of teeth on				No. of threads per inch of screw.	No. of teeth on				No. of threads per inch of screw.	No. of teeth on			
	Mandrel pinion.	Leading screw wheel.		Mandrel pinion.	Stud wheel.	Stud pinion.	Leading screw wheel.		Mandrel pinion.	Stud wheel.	Stud pinion.	Leading screw wheel.		Mandrel pinion.	Stud wheel.	Stud pinion.	Leading screw wheel.
1	80	40	8¼	40	55	20	60	18	40	60	20	120	32	30	80	20	120
1¼	80	50	8⅜	90	85	20	90	18¾	80	100	20	150	33	40	110	20	120
1½	80	60	8½	60	70	20	75	19	50	95	20	100	34	30	85	20	120
1¾	80	70	9¼	90	90	20	95	19½	80	120	20	130	35	60	140	20	150
2	90	90	9¾	40	60	20	65	20	60	100	20	120	36	30	90	20	120
2¼	80	90	10	60	75	20	80	20¼	40	90	20	90	38	20	95	20	120
2½	80	100	10½	50	70	20	75	21	80	120	20	140	39	40	120	20	130
2¾	80	110	11	60	55	20	120	22	60	110	20	120	40	30	100	20	120
3	80	120	12	90	90	20	120	22½	80	120	20	150	42	50	140	20	150
3¼	80	130	12⅝	60	85	20	90	22¾	80	130	20	140	44	30	110	20	120
3½	80	140	13	90	90	20	130	23¾	40	95	20	100	45	30	90	20	150
3¾	80	150	13½	60	90	20	90	24	65	120	20	130	45½	40	130	20	140
4	40	80	13¾	80	100	20	110	25	60	100	20	150	50	30	100	20	150
4¼	40	85	14	90	90	20	140	25½	30	85	20	90	52	35	130	20	140
4½	40	90	14¼	60	90	20	95	26	70	130	20	140	52½	40	140	20	150
4¾	40	95	15	90	90	20	150	27	40	90	20	120	55	30	110	20	150
5	40	100	16	60	80	20	120	27½	40	100	20	110	56	30	120	20	140
5½	40	110	16¼	80	100	20	130	28	75	140	20	150	60	30	120	20	150
6	40	120	16½	80	110	20	120	28½	30	90	20	95	65	30	130	20	150
6½	40	130	17	45	85	20	90	30	70	140	20	150	70	30	140	20	150
7	40	140	17½	80	100	20	140										
7½	40	150															
8	30	120															

DIFFERENTIAL SLIDE-MOTION FOR LATHES.

As your correspondent, "C. E.," wishes to know "how the spiral is attached to the screw of the slide-rest, and also what effect it has upon the screw," I beg to inform him that the most general method of attaching the spiral to the screw is by its centre being made to fit accurately upon the square at one end of the screw; but I would prefer its centre being put upon a stud fixed to the saddle of the lathe, and geared to the screw by two small spur-wheels, one of which must revolve with the spiral upon the stud, and impart its motion to the other upon the end of the screw. By the first method, one revolution of the spiral will produce one of the screw; and, by the second, the motion of the screw can be varied by simply altering the ratio of the diameters of the two wheels: thus affording an opportunity of forming a series of geometrical curves, of different curvature, upon one length of rod.

As to the "effect produced upon the screw," I must at once refer him to the illustration given at page 42 of your *Journal* for May.

Conceive the spiral, A C, to be toothed upon its circumference similar to a spur-wheel, and the curve, B C, toothed similar to an internal wheel. It is evident—according to the principle of this motion—that if the spiral traverses from A to B, it will make a complete revolution, and will impart a motion to the screw, whose velocity varies as the ordinates of the equation of the curve, B C. If the screw of the slide-rest were equal

in pitch to the line A C, and the length of the rod equal to twice A B, a curve similar and equal to A B C would be formed upon the barrel of the rod. Diminish the pitch, or number of revolutions of the screw, and we shall have a curve of less swell in the middle, and *vice versa*, still retaining the equation of the curve, A B C.

Many motions for the purpose of barreling are attached to slide-lathes, but none that I have seen will form a curve mathematically correct, and as "C. E." appears interested in the above motion, I beg to inform him that I have made a great improvement upon it, which I intend shortly to communicate to this *Journal;* but should he or any other parties interested, wish for early information respecting it, I shall be very happy to attend to their requests, on their addressing me as under.

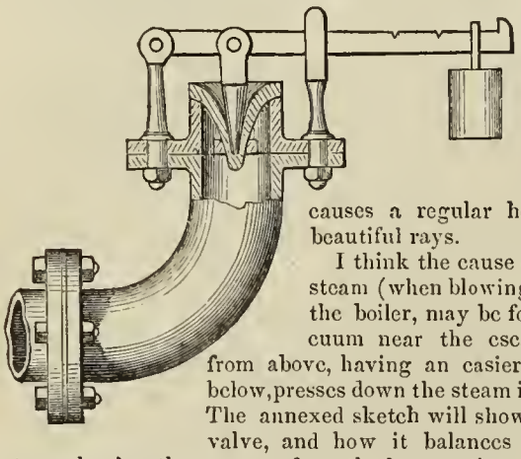
ROBERT MUCKELT.

3 *Charles Street, Crewe, June* 16, 1850.

PHENOMENON OF ESCAPE STEAM.

My present communication is occasioned by a phenomenon new and interesting to all those who have seen it, and a description of which may be acceptable to you.

The steam, when escaping out of my patent safety valve,* blows right down upon the boiler, instead of horizontally all round, as one might expect from the shape of the valve. Keeping a board horizontally over and near to it, causes a regular horizontal blowing in beautiful rays.



I think the cause of the direction of the steam (when blowing freely) being towards the boiler, may be found in the partial vacuum near the escaping steam; the air from above, having an easier access than that from below, presses down the steam into the lower vacuum. The annexed sketch will show you the shape of the valve, and how it balances freely upon escaping steam, having the pressure from the lever acting on a point between the guide of the valve.

C. SCHIELE.

Manchester, July, 1850.

FLOW OF WATER THROUGH PIPES.—FANS FOR VENTILATION.

I should be greatly obliged if you could obtain for me, through the *Practical Mechanic's Journal*, any information as to the rate of the flow of water through cast-iron pipes of given dimensions—say 9 and 12 inches diameter—connecting reservoirs at 200 or 250 yards asunder. The information is required for a specific case. One reservoir is already made, and the other, of an area of about two acres, is in process of construction. The first receives a small stream, and my employer proposes to connect the two by a pipe which I deem very insufficient for the purpose. Both reservoirs will be on a level, and the only pressure in the pipes will arise from flood water.

What is the most efficient size of fan, and the best speed for ventilation? I feel inclined to try one to take the steam out of a large dye-house.

O. P. B.

Rochdale, July, 1850.

WIRE-ROPE RAILWAY SIGNALS.

Could you inform me who is the inventor of the working of railway signals by wire, generally called "wire signals?" also, when and where the same was first applied? and, if the system has been patented in England? These questions inserted in your widely spread *Journal*, will, I have no doubt, find the required answers.

Paris, July, 1850. D. HUNTER BRANDON.

[We presume our correspondent refers to the contrivance described by us at page 149, vol I. We are not aware who first suggested the idea, but believe it originated with the officials of the North British line, where it was forced upon them by the objectionable working of the sliding rods. If Mr. Brandon refers to the page we have quoted, he will see that a wire rope has been substituted for the original single electric telegraph wire. It is not patented.—ED. P. M. JOURNAL.]

* Constructed on the principle of the ingenious anti-friction curve, figured and described at page 50, Vol. II., of this *Journal*.—ED. P. M. J.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTION

7TH JUNE.

Professor Faraday "On Certain Conditions of Freezing Water."

The last Friday evening meeting of the session was occupied with this subject, and the results of the researches made by this celebrated chemist appear to point to discoveries of importance, as the following concise report of the discourse will show:—The professor commenced by calling attention to the extraordinary attraction exhibited by particles of water among themselves, as compared with particles of water with other things. Chemical affinity and chemical attraction are but names of proceedings in nature which we do not as yet understand. He alluded to the purity of ice, and exhibited a block, weighing 140 lbs., from Norway, whence ice is now ordinarily obtained, and not, as lately, from America. There is no purer substance than ice, and this purity is attributable to the perfect expulsion from water of everything but itself. He stated there was no trace of salt in ice produced by freezing salt water, and experimentally showed the greater purity of water obtained by melting ice over common cisterns, and well-water, by the introduction of nitrate of silver into each. A still more perfect test was chosen, by the admixture of a solution of soap in spirits of wine. To show how this purity could be perfectly attained, notwithstanding apparently adverse circumstances, he mixed some water and sulphate of indigo, and by one of those happy expedients, for which he is famous, froze the mixture in a freezing compound by a revolving motion with one hand, as he kept stirring it with the other with the feather end of a quill, so as to produce a cylinder of the purest ice. The experiment was repeated, with mixtures of water and sulphuric acid, and even of water and ammonia, and chemical tests were applied, to show the absence of all these several ingredients in the water produced from the ice thus made, and the concentrated character of the residuum. By freezing all the water, he asserted that highly concentrated forms of these foreign bodies were produced. He showed by experiment, a fact which, previous to experiment, he had deduced by mere reasoning, in submitting ice to a heat of 300° fahrenheit, when not exposed to the air (as under oil), which also renders water impure—and it exploded. He showed the fact of ice freezing to ice, and suggested some important consequences following from it: a similar power is created in a common snowball. But the introduction of gold leaf between two plates of ice prevents consolidation. He alluded, in glowing terms, to the labours of our distinguished townsman, Dr. Thomson, on the subject of the influence of pressure on freezing water. A pressure of eight atmospheres will lower the temperature of water, which while under the influence of fifteen atmospheres, will freeze; but an immense pressure prevents freezing. This pressure tends to liquify ice, and *vice versa*. It is unnecessary to point out to our readers, as Mr. Faraday appeared to think it unnecessary to him, the necessity of the law of gravitation, being taken into consideration in chemical theory, as these experiments show it should. The lecture was listened to with the deepest attention and interest by the most crowded audience of the session, comprising a large body of scientific men, and fashionables, whom we are always happy to see together.

SOCIETY OF ARTS.

JUNE 5.

Mr. Ricardo, M.P., presided at this, the last meeting of the session.

A paper, by Mr. Smith, C.E., was read, explaining a project for embanking the Thames from Vauxhall Bridge to Blackwall, including a plan of sewage, wharfage, a railroad, and the supply of water and gas. He proposed that the embankment should be hollow, and should be reclaimed from the river; that the pipes for carrying the sewage, pure water, and gas, should be sunk below low-water mark, in a tunnel similar to the dry arches of the Adelphi; and that this tunnel might have a railway laid down in it, communicating by steep inclines with the leading thoroughfares. The arch of this tunnel would support loading wharves, one foot above high-water mark, from which would spring arches opening towards the river, and supporting an esplanade of sixty feet in width for ordinary traffic. He stated that the purity of the Thames had not always been neglected by the legislature, inasmuch as, in the time of Richard II., an act of parliament was passed, imposing a fine of 1s. 8d. on any person polluting its waters, and similar provisions were to be found in subsequent acts. The discharge of the sewer water was to be made by intercepting sewers parallel to the banks, which should ultimately unite in a cutting, running through the Essex marshes into the mouth of the Thames. The expense of this plan he estimated at £3.000,000.

Mr. Boccius explained a plan of getting rid of the London sewage and turning it to useful account, for which he and Mr. Stothard had obtained a patent, and which would shortly be brought before the public. It consisted in intercepting the present sewage and conveying it to receptacles, whence, by the help of powerful Cornish engines, it would be pumped up to large reservoirs on the high grounds surrounding the metropolis, where, by the process of which he claimed to be the discoverer, it would be instantly deoderized, and all the salts, phosphates, ammonia, &c., would be precipitated—the muriate of soda alone excepted. The precipitate would be disposed of as manure, and the surplus water would be employed in flushing the

sewers, until it became too strongly impregnated with salt, when it would be carried away by a discharge-pipe into the salt water of the river.

This plan, if the statement of its projector can be proved, seems to leave nothing to be desired, as the valuable contents would be preserved, and the river completely freed from impurities.

The material used for deoderizing he would not at present explain, further than that one principal ingredient was bituminous shale, and the effect of a small quantity applied to a large cesspool was quite instantaneous.

It was announced at the close of the meeting, that the designs for the medals of the exhibition of 1851, sent in by the various competitors, would shortly be exhibited in the rooms of the society.

ROYAL SCOTTISH SOCIETY OF ARTS.*

It has been observed that those waters in which the best fish are bred are the best fitted for irrigation; but most of the benefits of the system may be derived from any kind of water, with the exception of sewerage-water.

All, however, that has been done in this country in the way of irrigation, dwindles into insignificance, compared with what is now going on in India, and as to which it may not be out of place to make a few observations; for although the subject is primarily *agricultural*, it may yet be made to promote commerce generally to a very considerable extent.

It is well known that the waters of the Ganges are much more fertilising than the streams of this country, arising from the rich mud with which they are impregnated, said to be frequently two hundred parts of its volume. It is to some of those engineers who have visited the country that we must look for further information on this very interesting subject.

It has been said that he who has caused two blades of grass to grow where only one grew before, is to be regarded as a benefactor of his country. But how much more are those entitled to the appellation who, either by *withdrawing* moisture from the soil in which it exists *in excess*, or by creating and regulating the supply where it is wanting, convert thousands and tens of thousands of acres of land, hitherto a desert, or wholly unproductive, into fruitful fields, and thereby not only enlarge prodigiously the supplies of food for man, but increase the facilities for the production of cotton, flax, and other raw materials, so extensively in demand by our manufacturers.

Docks, Harbours, and River Improvements.

On the subject of harbour and river improvements there is also great scope for very interesting papers. The docks of Liverpool are remarkable for their extent and completeness; those of Hull for the difficulties required to be surmounted in the course of their construction, of which there exists in the publisbed Transactions of the Institute of Civil Engineers, a very full account.

The docks of Bristol and Aberdeen are also works of considerable interest, and are similar in their general arrangements; the river Frome in the one case, and the Dee in the other, having been converted into a dock, while new channels have been provided for the streams. The works at Bristol have been formed for many years; but the great lock for the harbour at Aberdeen is at present in course of construction, and is intended to admit the largest class of steam-ships.

In the improvement of rivers, much has been done; but by far the most remarkable instance of success in this branch of engineering in Scotland is on the Clyde. When the first act for the improvement of this river was obtained in 1758, the revenue for shore dues appears to have been about £150 per annum; and vessels drawing more than 2½ or 3 feet water could not at that time reach the harbour at Glasgow; whereas the revenue is now about £60,000 per annum, and the river is navigable by vessels of 1,000 tons burthen, and drawing from 17 to 20 feet water.

Floating Wharves.

The very rapid extention of river navigation by steam vessels has rendered greater facilities for the embarkation and debarkation of passengers desirable, if not essential, and the greater the range of the tide, the greater is the necessity for a wharf accommodating itself to its rise and fall. That which has recently been placed on the River Mersey at Liverpool (where the range of the tide is 30 to 35 feet, or 15 feet greater than on our coast), is the most important in this kingdom. It consists of a barge of gigantic dimensions, alongside of which steamers are brought; and on which carriages draw up; such is the magnitude of this barge that it may be regarded as a floating pier.

Another work of this class, and of which I should like to see an account, is that at Goole. This floating stage is also of gigantic proportions, being 400 feet in length, and 56 feet in breadth. It is placed on the Humber, where a railway is being formed to connect Hull with the south.

Iron Roofs for Engine, Carriage, and Passenger Sheds on Railways.

The application of iron for the purpose of roofing is of but recent date; and the span did not at first much exceed those of timber roofs. They were, however, soon extended to 50 and 60 feet, and these were considered bold spans. They have now been increased to more than the double of the largest of these dimensions. The two most remarkable, with which I am acquainted are now being erected at Liverpool: That at the terminus of the Liverpool and Bury Railway has a span of 135 feet; and that at the Lime Street Station of the London and North Western Railway is, I believe, 160 feet. The span of the roof of the station recently erected at the Perth terminus of the Scottish Central Railway, although not so great as those at Liverpool, just referred to, is, nevertheless—whether considered with reference to the design or workmanship—a beautiful specimen of iron roofing.

The iron roof of the locomotive engine-house at Burntisland, the diameter of which is 140 feet, is not devoid of interest.

Viaducts.

Several very magnificent viaducts have recently been erected in this kingdom, as well as on the continent of Europe. In Scotland, one of the most interesting is that over the river Ayr at Ballochmyle in Ayrshire. The *way* is about 181 feet above the level of the river; and the span of the main arch is no less than 180 feet.

Tunnels.

There have also been constructed, during the last eight or ten years, in various parts of this country, several very extensive tunnels, the chief of which are in Yorkshire.

Chimneys for Public Works.

I believe that this Society is already possessed of a good deal of information respecting the great chimney at St. Rollox, Glasgow, the height of which is about 435 feet, an elevation above the level of the sea equal to that of the base of Salisbury Craigs, in the neighbourhood of this city. But I am not aware that we have yet received a drawing and description of the great gas-work chimney in this city, which is a much more stupendous structure than that at St. Rollox. As this chimney was erected from the designs of Mr. Taylor, the Gas Company's engineer, with the advice and assistance of Mr. George Buchanan, the gentleman from whom we have already obtained such valuable papers, I do not despair of obtaining a general description of it for the Society.

The best mode of arranging Railway Trains, with a view to the Safety of Passengers.

Some very interesting and valuable papers have been communicated to this and similar institutions, suggesting various methods by which to secure a ready communication between engine-drivers and guards, and also between passengers and guards. This certainly is a most important subject, but so far as I am aware, nothing has yet been proposed of a very satisfactory kind—which is to be regretted. There is, however, another matter connected with railway trains of still greater importance to passengers. *I mean the arranging or placing of the carriages.* I am well aware that it is impossible to lay down rules for this purpose, which can be strictly adhered to in all circumstances; but I think there is yet much to learn on this subject; and a well-considered paper, by an intelligent and attentive observer, *practically* conversant with the working and arrangement of passenger trains, would be important, and tend to the formation of much more correct views on this important branch of railway management.

There is another matter connected with the safety of passengers, as to which, I believe, that railway engineers are quite agreed, and that is, the importance of having the *centre of gravity* in engines and carriages brought *as low as possible.* As respects locomotive engines, Crampton has done much to attain this most desirable object.

I am the more anxious to see a good paper on this subject, as I have always thought, and do still think, that a mistaken notion but too generally prevails as to the degree to which the risk of passengers—such as it is—is referable to *speed*, and how far to other causes. My own opinion is, that very little of this risk is due to the high *velocity;* and that much more depends on the mode in which the trains are arranged, with reference to the position in which the *heavy trucks* are placed. In support of this view, I may be allowed to refer to two railway accidents which have occurred during the present year.

The first is that which occurred to the express down-train on the York and Newcastle Railway, on 3d March last. When this accident took place, the train was travelling at the rate of 45 or 50 miles an hour, the engine was thrown off the rails, and the carriages overturned; but although the driver was killed on the spot, and the stoker died on the following morning, not one of the passengers (of whom I was one) was in the least hurt. Their immunity from injury, I am satisfied, is very much to be ascribed to the absence of any heavily loaded trucks in the rear of the passenger carriages.

In the case of the accident which happened on the Caledonian Railway, near Carlisle, a few weeks before that to which I have alluded, the velocity at the time was understood to be little more than *eighteen miles* an hour. Nevertheless six or seven of the passengers were killed on that occasion. The loss of life, I am convinced, would not have been so great, if indeed any would have occurred at all, but for the post-office van, horse-boxes, and other heavy carriages which were placed in the rear of those for passengers.

The only other branch of engineering to which I shall on the present occasion advert, and on which it would be desirable to have papers before us, descriptive of recent improvements, and its present state, is that of—

Locomotive Engines.

Communications by engineers, intimately and practically acquainted with the construction and working of these powerful machines, would be an invaluable contribution to this Society. It is well known, that these engines vary most materially in the consumption of fuel; and the results of a series of careful observations of the variations in the consumpt, with equal loads, under different circumstances, and at different velocities, would constitute very valuable information at the present time, when the subject of the working *expenses* of railways has assumed a degree of importance which it never hitherto possessed.

It is well known, that the monthly returns which are published of the fuel consumed, and the work performed by the stationary Cornish engines, have contributed in no small degree to bring that class of engines to their present high state of perfection. It is not, therefore, too much to assume, that similar returns for locomotives employed on our leading lines of railway, would tend much to the general adoption of the class of engines which prove, under all circumstances, the most economical.

P

* Concluded from page 94.

It will not, I trust, be considered foreign to the object of these remarks, if I advert to a question which has been frequently asked, but has never yet been answered in a manner so satisfactory as seems to be desirable. The question is—To whom is due the credit of having been the first in this country to suggest the possibility of locomotive engines being made to travel at some such speed as 20 miles an hour? To those who have had their attention directed to this subject, it is pretty well known, that to the late eminent engineer, Mr. George Stephenson, this merit has been awarded. I have given this matter some consideration, and the conclusion at which I have arrived is, that this merit is due to a distinguished fellow-citizen, Mr. Charles Maclaren, who not only promulgated his views, but assigned reasonable grounds for the truth of them.

It may be in the recollection of several gentlemen now present, that in December, 1824, Mr. Maclaren published, in the Scotsman newspaper, a series of papers in which the subject of the transit of locomotive engines on railways was investigated. The primary object of these essays was to develope the theory of the motion of carriages on railways, as deduced from the laws of friction, from experiments made by Vince and Coulomb; and to point out the vast superiority afforded by this mode of propulsion, wherever it was desired to obtain a *high velocity*. These experiments established that, while the resistance to bodies moving on water increases as the *square of the velocity*, that presented to sliding or rolling bodies (irrespective of the resistance of the atmosphere), *is equal in equal times*, or,—the *same at all velocities*,—or, as Mr. Maclaren expresses it—"The same constant power which would maintain a velocity of two miles an hour, would equally maintain a velocity of twenty miles an hour."

Mr. Maclaren further says:—

"When the steam-coach is brought fairly into use, practice will teach us many things respecting it, of which theory leaves us ignorant. With the facilities for motion which it will afford, however, there is nothing very extraordinary in expecting to see the present extreme rate of travelling doubled. We shall then be carried at the rate of 400 miles a day, with all the ease we now enjoy in a steam-boat, but without the annoyance of sea-sickness, or the danger of being burnt or drowned. It is impossible to anticipate the effects of such an extraordinary facility of communication when generally introduced."

These essays, as I have already stated, were published in December, 1824, and clearly show, that the author entertained the opinion, that with steam, high velocities were quite attainable.

As respects the view which the late Mr. George Stephenson held, prior and subsequent to this time, we have it clearly expressed on two occasions,—the former in June, 1821, in a letter addressed to Mr. Robert Stevenson, the eminent engineer of this city, and of which a copy is now before me; and the latter when giving evidence before the Committee on the Manchester and Liverpool Railway Bill, in May, 1825. The one being 3½ years before, and the other six months after the time when Mr. Maclaren's papers were published.

The following is an extract from the letter from Mr. George Stephenson, above referred to, dated Killingworth Colliery, 28th June, 1821:—

"I have lately started a new locomotive engine, with some improvements on the others which you saw. It has far surpassed my expectations. I am confident that a railway, on which my engine can work, is far superior to a canal. On a long and favourable railway, I would stent my engines to travel sixty miles a-day, with from forty to sixty tons of goods."

This, it will be observed, is not sixty miles an hour, but sixty miles *a day* of twenty-four hours; or, two and a half miles an hour; or, what is more likely to have been in Mr. Stephenson's view, five miles an hour of twelve hours a-day.

Then, as to Mr. Stephenson's views in 1825,—in answer to a question as to the speed at which a locomotive engine might travel, he answers, "Five or six miles without any extra danger." To another question to the same effect, he answers that he had "recommended eight miles an hour with twenty tons of a load, and four miles with forty tons; and I am quite confident that more might be done." Mr. Stephenson's opinion as to the extent to which increase of speed might be carried may be ascertained from the two questions and answers which follow:—

"Do you consider it beyond all question that they could go at six miles?—I consider it beyond all question they could go at eight.

"And you are within the mark?—Yes; I have no doubt they might go at the rate of twelve miles."

The views entertained by Mr. Nicholas Wood, on this subject, as elicited before the same committee, may be gathered from his answers to the following questions:—

"Have you any doubt that a locomotive engine could be made to take the weight of 40 tons, at the rate of six miles an hour, with perfect safety?—An engine may go six miles an hour with forty tons—that is, including the weight of the carriages.

"Have you any doubt that the power of the engine might be so increased as to take that weight at any speed between six and twelve miles an hour?—I think the power of the engine may be increased to take that weight.

"To what extent do you conceive the power of the engine could be increased to take that weight of goods?—I can scarcely state that to you, the power of the engine may be increased very greatly.

"As much as double?—I think it might.

"If you had such an engine, in your opinion could it be made to go with perfect safety twelve miles an hour with relation to the bursting of the boiler?—Yes, I think it might."

My friend Mr Wood's views on this subject were still more clearly brought out, in the edition of 1825, of that gentleman's excellent Treatise on Railways, in which he speaks of high velocities in a very discouraging strain, thus:—

"It is far from my wish to promulgate to the world that the ridiculous expectations—or rather professions—of the enthusiastic speculatist will be realised; and that we shall see engines travelling at the rate of twelve—sixteen—eighteen—twenty miles an hour. Nothing could do more harm towards their general adoption and improvement than the promulgation of such nonsense."

In thus stating my views on this subject, I beg to disclaim all intention of detracting from the great merits of that eminent mechanical and civil engineer, whose loss we all deplore; I do so solely from a desire to see justice done to Mr. Maclaren.

February 11, 1850.

"On the relative value of Chlorine, Nitric Acid, Sulphurous Acid, and Ozone, as disinfectants; and on the best method of applying them to the destruction of Contagious Matters," by George Wilson, M.D.

The author dwelt at length upon the relative value and best mode of applying, as disinfectants, the different substances mentioned in the title of this paper. A chief object of the communication was to draw attention to the alleged virtues of ozone as a purifier of the atmosphere, and to notice that, in defect of any other disinfectant, ozone might be generated in apartments, the air of which was vitiated by animal exhalations. The simplest process for this purpose would be the exposure of moist phosporous to air; but an electrical machine or voltaic battery might also be used.

The other point at which the author aimed was to show the unwise neglect of sulphurous acid as a disenfectant, or rather antiseptic, which had been practised. It appears, according to Dr. Wilson, that in the wine countries this gas is employed to arrest the acidification of the weaker wines; that in the Manchester Dye Works it is found more efficacious than chlorine in destroying the offensive odour which attends the employment of cochineal; and that at paper mills it is employed with great success to prevent the putrefaction of the *scrolls* or clippings of skin used in the manufacture of the paper size.

The author accordingly strongly recommended sulphurous acid as a cheap and powerful deodoriser and disinfectant.

"Remarks on the Philosophy of the Beautiful—and an Analysis of the principle of Proportion, as applicable to Architecture" (Part I.), by David Cousin, Esq., Architect.

The author combated the definition of the beautiful, as laid down by the late Mr. Alison and Lord Jeffrey, and held that beauty was recognised by the mind in particular *forms*, independently of any association connected with the object which it admires.

The first part of the communication was entirely metaphysical, and cannot well be given in abstract. The author will read at the next meeting the second or practical part of his paper, showing how Mr. Hay's principles of proportion, determined by angles bearing harmonic ratios to each other, can be applied to architecture.

"An Exposition of the Art of Navigation, as applicable to Inland Transit, and of the Works by means of which our Communication with the Ocean is improved and maintained," by David Stevenson, Esq. Illustrated by various hydrometrical instruments, diagrams, and plans, including, by permission of the Perth Harbour Commissioners, their plan of the river Tay from Perth to the Gaa Sands, on a scale of six inches to the mile.

Mr. Stevenson believed he was perfectly safe in affirming, that nothing had occupied a more prominent part in the work of civilizing the world than the art of navigation, which had slowly but steadily progressed since the commencement of the fourteenth century, at which early period the introduction of the mariner's compass opened up a new era in the history of maritime discovery, and gave an entirely new character to commercial enterprise. In its more extended sense, the subject of navigation had, for the last 400 years, formed the grand object on which the labours of Columbus, and of all subsequent explorers of the world, had been expended; while the researches of the philosopher, the astronomer, the geographer, the mechanician, and the engineer, had all been instrumental in bringing to their present maturity and perfection the various branches of which the vast system of navigation, as it now existed, was made up.

It was not, however, to the subject in that comprehensive sense that he had the honour, at the request of the Council, to direct the attention of the Society. Such an exposition would embrace too wide a field, and lead to the discussion of topics which would not fall within the scope of civil engineering; and he would therefore confine his observations to that branch of navigation which he defined as the department which intervened between the ocean and the land—a connecting link, the true importance of which could be correctly estimated only when viewed in connection with the vast importance of the whole system of which it formed an indispensable part. For how, he asked, could we be benefited by those mighty results of science and of art, by which sailing vessels of all classes were now enabled to transport their cargoes from shore to shore with comparative ease and safety, and gigantic steamers to cross the Atlantic with certainty and despatch, did we not extend the beacon light to welcome their approach to our coasts, and provide the means of their withdrawing from the ocean billows into sheltered havens, where their lading might be discharged, and cargoes of our country's produce shipped for foreign lands? For it must be remembered, that it was only when a mariner approached his destined port that the many dangers caused by rocks, shoals, sandbanks, tides, and currents, beset his course; and hence the necessity of employing artificial means to secure that shelter and protection which his vessel required. It would at once occur to the Society that works of various kinds were employed for this purpose. One class of these works consisted in the projection of piers and breakwaters at suitable situations on the coast, so as to form sheltered havens and harbours of refuge. To another department belonged ship canals, by means of which exposed coasting voyages were avoided, and vessels were brought by sheltered and direct routes to their destination; while, closely connected with this, might be mentioned the system of inland navigation as effected by means of canals and the upper compartments of rivers. And, last of all, there was that varied class of works by which inlets of the sea, and tidal compartments of rivers, extending from the coast into the country, were opened up and rendered navigable; and he observed in passing, that these various works, connected with the improvement of navigation, formed by far the most extensive and intricate department of hydraulic engineering.

On the subject of harbours, formed by the projection of piers and breakwaters,

he did not intend to enter at present, and only requested the attention of the Society, while he endeavoured to convey an outline of what he conceived to be the extent of our knowledge with reference to the subjects of inland and tidal navigation.

Mr. Stevenson said, that the antiquity of navigable canals—their wide-spread introduction for the transport of goods—and the important place which they had so long occupied in the commercial history of every country, rendered their origin and subsequent progress worthy of attentive investigation; but that only a very brief notice of that class of works could be given. And on that subject he remarked, that from the writings of Herodotus, Aristotle, Pliny, and other ancient historians, we learned that canals existed in Egypt before the Christian era; and at the same early period there was reason to believe that artificial inland navigation also existed in China. Almost nothing, however, save their existence, had been recorded with reference to these very early works; but soon after the commencement of the Christian era canals were introduced, and gradually extended, throughout Europe, particularly in ancient Greece, Rome, modern Italy, Spain, Russia, Sweden, Holland, and France.*

In speaking, however, of the earliest of these works, Mr. Stevenson said, that it was not to be supposed that they resembled the present system of inland navigation, as practised and known in this country. Early as canal navigation was introduced, it was not until the invention of canal-locks, by which boats could be transferred from one level to another, that the system was rendered generally applicable and useful; and a writer in the Quarterly Review remarked, "that to us, living in an age of steam-engines and daguerreotypes, it might appear strange that an invention so simple in itself as the canal-lock, and founded on properties of fluids little recondite, should have escaped the acuteness of Egypt, Greece, and Rome."† But not only had the invention escaped the notice of the ancients, but the several gradations made towards the attainment of that simple but valuable improvement, appeared to have been so gradual, that, like many discoveries of importance, great doubts existed, not only as to the *person*, but even as to the *nation* by whom canal locks were first introduced. One class of writers attributed the discovery to the Dutch, and Messrs. Telford and Nimmo, from whose pen the article on Inland Navigation in Brewster's Edinburgh Encyclopedia, was understood to have emanated, adopted the conclusion that locks were used in Holland nearly a century before their application in Italy; while, on the other hand, the invention had been strongly, and not unreasonably claimed by engineers of the modern Italian school, and, in particular, for Leonardo da Vinci, the celebrated engineer and painter. Without, however, entering into a discussion on this subject, he would simply remark, that during the 14th century the introduction of locks, whether of Dutch or Italian origin, gave a new character to inland navigation, and laid the basis of its rapid and successful extension. And here he said that it might be proper to remark, that the early canals of China and Egypt, although not possessed of locks, were not on that account unadapted to difference of level. It was very doubtful, indeed, if the use of locks had even yet been introduced into China, though intersected by many canals of great extent, the Imperial canal being nearly 1,000 miles in length; and it accordingly appeared that in order to pass boats from one level to another, a rude system of stop gates and inclined planes had been in use from very early times in that country. Nevertheless the introduction of locks might be held as an important step in the history of inland navigation, and they might be said in Europe and in America to be almost universally used. It was true that inclined planes had been adopted even in this country—in particular on the Shrewsbury and Shropshire canals—and Messrs. Leslie and Bateman had lately recommended this system to the Directors of the Forth and Clyde canal—but the instances of its application were confessedly rare; and, indeed, the only place where he had seen inclined planes extensively used, was at the Morris canal, in the United States, constructed by Mr. Douglas of New York, where several planes were in use, having gradients of about 1 in 10, by which boats weighing, when loaded, about 30 tons, after being *grounded* on a carriage, were raised by water-power through a space of 50 perpendicular feet with great success.

But in proceeding to illustrate the progress of inland navigation, he might, without tracing its gradual introduction from country to country, remark at once that we found the French at the end of the 17th century, in the reign of Louis XIV., forming the Languedoc Canal between the Bay of Biscay and the Mediterranean—a gigantic work, which was finished in 1681. It was 148 miles in length, and the summit level was 600 feet above the sea, while the works on its line embraced upwards of 100 locks, and about 50 aqueducts, the whole forming an undertaking which was a lasting monument to the skill and enterprise of its projectors; and with this work as a model, it did seem strange that Britain should not, till nearly a century after its execution, have been engaged in vigorously following this notable example; and this seemed the more extraordinary, as the Romans in early times had executed works in this country which, whatever might have been their original use, whether for the purposes of navigation or drainage, were ultimately, and that even at an early period, converted into navigable canals. Of these works he particularly specified the Caer Dike and Foss Dike cuts in Lincolnshire, which were by general consent admitted to have been of Roman origin. The former extended from Peterborough to the river Witham, near the city of Lincoln, a distance of about forty miles, and the latter extended from Lincoln to the river Trent, near Torksey, a distance of eleven miles. The Caer Dike existed now only in name, but the Foss Dike was at this moment an efficient and flourishing navigation; and having been lately professionally engaged in its improvement, Mr. Stevenson stated that he had occasion to inquire somewhat minutely into its past history and condition, and that a very few particulars regarding that the *oldest* British canal, might not be uninteresting. Among other notices of this early work, Camden, in his *Britannia*, stated that the Foss Dike was a cut originally made by the Romans, and that it was deepened by Henry I., who reigned in the eleventh century, but to what extent it was so deepened, did not appear. In 1762, it was reported on by Smeaton and Grundy, who found the navigable depth at that time to be 2 feet 8 inches, and recommended several works for its improvement, which appeared, however, not to have been executed. In 1782, Smeaton was again employed, and deepened the navigation to 3 feet 6 inches; but it did not appear that its width was increased; and from that period it remained in a very imperfect state till 1840, when the lessee of the navigation employed the firm of which he was a member, to design works for assimilating the Foss Dike, both as regarded the breadth and depth of the navigable channel to the rivers Witham and Trent, with which it communicated. When called on to examine the navigation, Mr. Stevenson found its depth to be 3 feet 10 inches, and its breadth in many places was insufficient for the passage of boats, for the convenience of which, occasional passing places had been provided; and it was resolved to increase its dimensions, and otherwise repair the whole work. Accordingly, the canal was widened to the *minimum* breadth of 45 feet, and deepened to the extent of 6 feet throughout (alterations which were accomplished without stopping the traffic); the entrance lock was removed, and a pumping engine was erected for supplying water from the River Trent during dry seasons; and that ancient canal, which was quoted by Telford and Nimmo "as the oldest artificial canal in Britain," was now in a state of perfect efficiency, forming an important connecting link between the Trent and Witham navigations.

Notwithstanding the existence of this early work, however, and of some others in the country, particularly the Sankey Brook navigation, opened in 1760, Mr. Stevenson said that it was generally admitted that the formation of the Bridgewater Canal in Lancashire, the act for which was obtained in 1755, was the commencement of the system of British canal navigation, and that Francis, Duke of Bridgewater, and Brindley, the engineer, who were its projectors, were the first to give a practical impulse to a class of works which now pervaded every corner of the empire, and had been of vast importance in promoting its commercial prosperity.

That the railway system, from the introduction of which we have of late years derived such inestimable advantages, had now, in a very great measure, superseded, and certainly for the future must prevent the extension of canals as the means of internal communication, Mr. Stevenson said, was undeniable; and hence, at first sight, it might appear to some that he was consuming the time of the Society with the details of a subject which, in the present day, might be pronounced to be obsolete. But he reminded the Society, that although this remark might perhaps be considered applicable to such canal works as were intended for the purpose of effecting purely inland communication from town to town, it did not in any degree apply to that more extended class of works called ship canals, which, like the improvement of tidal navigations, were executed for the purpose of enabling sea-borne vessels, by taking an inland course, to avoid the dangers of lengthened coasting voyages—an object of the highest importance to navigation, and which, it was obvious, could not be superseded by the railway system. He presumed, therefore, that he need offer no apology for describing very briefly the characteristics of such canals by reference to works actually executed; and for this purpose he referred to the Great North Holland Canal, the largest of the kind in the world. That canal, which extended from Amsterdam to the Helder, a distance of forty-five miles, was finished in 1825. It had a cross sectional area, measuring 125 feet in breadth at the surface, 30 feet at the bottom, and no less than 22 feet in depth of water; and what was most worthy of notice, and was, indeed, a characteristic of all the Dutch engineering works, the whole was protected from the German Ocean by embankments, faced with wicker work, the surface of the water in the canal being below the level of the sea. At the time he inspected it, the sea was 5 feet higher than the surface of the water in the canal, and the vessels were actually *locking down* from the ocean into the fertile plains of Holland. Its construction was intended to enable vessels trading with Amsterdam to avoid the islands and sand-banks of the dangerous Zuider Zee, the passage through which, in former times, often occupied as many weeks as the transit through the canal now occupied hours. But our own country furnished us with a similar work of great magnitude and boldness: he alluded to the Caledonian Canal, which formed an inland navigation, composed partly of natural lakes and partly of artificial canal, extending from Inverness to Fort-William, a distance of sixty miles, and afforded a depth of 18 feet of water. By means of this inland communication, vessels were enabled to avoid the dangers of the Pentland Firth, and also the intricate navigation of the Western Islands; and while the Dutch, in their great canal, had to encounter the difficulties occasioned by the proverbial *lowness* of their country, Telford, in constructing the Caledonian Canal, had to deal with the ruggedness of a succession of Highland glens, and to overcome the summit level of Loch Oich, which was about 100 feet above the level of the sea; and accordingly, in addition to many heavy works which occurred in its course, there was at one point on the Caledonian Canal, a succession of eight locks, by means of which a vessel of the largest class of merchantmen could be raised or lowered through a height of 60 perpendicular feet. The locks, which were in close succession, rose one above another, like a series of gigantic steps, and this unique and extensive marine ladder had not inappropriately been termed "Neptune's Staircase."

* Fulton on Canal Navigation: London, 1796. Vallancey's Treatise on Inland Navigation: Dublin, 1763. Tatham's Political Economy of Inland Navigation: London, 1799. Inland Navigation, Brewster's Edinburgh Encyclopedia.

† Quarterly Review, No. 146, p. 281.

March 11.

"On a New Totally Reflecting Spherical Mirror for Harbour Lights and Sea Lighthouses," by Thomas Stevenson, Esq., C.E.

The author, as explanatory of his last improvement in sea and harbour lights,

again described the metallic holophotal apparatus which he formerly brought before the Society, and which is the only instrument hitherto constructed which collects all the diverging rays which emanate from a lamp, so as to throw them forward in one parallel beam to one point of the horizon. As formerly explained, this instrument is composed of three parts—a parabaloidal mirror, having the conoidal portion behind the perameter cut off, and its place supplied by a hemispherical reflector, whose centre thus coincides with the focus of the paraboloid, while in front of the flame is placed an annular lens subtending at the focus of the paraboloid, the same angle as that which is subtended at that point by the greatest double ordinate of the reflector, and having its principal focus coincident with that of the paraboloid. This instrument should produce the most intense light yet derived from any given flame, as it incloses and renders parallel each ray of the whole sphere of light, so that none are lost by divergence between the lips of the reflector; whereas, in the present arrangement, not very much short of one half of the rays escape. The author stated that he had introduced a light of this kind as a harbour light at Peterhead, which had been found to answer every expectation, although it is constructed of brass instead of silver. Experiments had been lately made at Gullan Hill, on the comparative power of a brass harbour light of this construction, and a highly finished silver reflector of the usual construction. The lights were viewed at distances of from seven to twelve miles every night during a week, and in every instance the brass harbour light, on the author's principle, had the advantage of the silver reflector, although the former cost only half as much as the latter, and on one occasion, when the atmosphere was thick, the brass harbour light was the only one that could be seen. As the great objection to red, green, and other coloured lights, is the enormous loss of light by absorption, the author considers this apparatus specially adapted to all coloured harbour lights. Though the above arrangement be as perfect as the nature of the material employed (silver or brass) will admit, yet it has been found by the most accurate experiments of scientific observers, that nearly one-half of the whole light incident upon even the most perfect metallic specula is lost by absorption. With the view of perfecting the holophotal system, to adapt it still more for sea or coast lighthouses, the author proposes to substitute total reflection, of that in which not a ray of light is lost, by means of glass prisms or zones of peculiar construction. The cross section of Fresnel's catadioptric zone is supposed to revolve vertically round the horizontal axis of the lens, thus producing an instrument between the lens and the flame whose action is, as it were, lenticular, or quaquaversal, instead of being only in one plane. This system of zones and lens renders parallel the whole of the anterior sphere of rays which proceed from the light, while the posterior hemisphere of rays is received by a system of concentric zones, also of glass, each of which has a catadioptric action similar to that of a right angled triangular prism, and somewhat akin to that of the drops of rain on the sun's rays which produces the rainbow. The first or inner surface of each zone being concave, and having its centre in the focus, will, theoretically speaking, receive its ray as a normal. A small part of the light will be reflected back to the radiant point, and the rest will enter the prism without suffering refraction. The other two surfaces of each zone, which are convex, are portions of paraboloids facing each other, and meeting at the apex of the triangle, and having also their common focus in the centre of the hemisphere. In this way, a ray proceeding from the focus enter the first or spherical surface of the prism without refraction, suffers total reflection at the second, in a direction tangential to the sphere, again suffers total reflection at the third, and emerges without refraction from the prism through the focus to the anterior portion of the flame, thus adding to the useful effect of the illumination.

"Description of the Ballochmyle Viaduct over the river Ayr, on the line of the Glasgow and South-Western Railway." By William M'Candlish, Esq., Resident Engineer.

This viaduct, it was stated, carries the Cumnock Extension of the Ayrshire Railway (which, on amalgamation, becomes part of the Glasgow and South-Western Railway) over the river Ayr, about a mile from the village of Mauchline. In order to attain the summit of the country near Cumnoch, the line required to cross this river at an elevation of 178 feet above its bed. The river is about 100 feet wide, and runs between high rocky banks, which are used as abutments from which to spring the great arch. The viaduct consists of seven arches, the centre one being 180 feet in span, and the three on either side of it being 50 feet in span each, and all semicircular in form. The arch-stones of the great arch are, on the outside, 5½ ft. deep at the springing, and 4½ ft. at the crown, but inside they were about a foot deeper. To give an idea of the magnitude of the viaduct, let it be compared with the Dean Bridge, near Edinburgh. If placed with the river bed on the same level as that of the Ayr, the roadway would stand 65 feet below that of the Ballochmyle bridge, and the great arch of the latter would span two arches of the former. Again, if Lord Melville's monument in St. Andrew's square were placed beneath the great arch, the head of the statue would not reach the crown of the arch. The stone of which the bridge is built is a close grained red freestone, and was obtained from quarries opened on either side of the river, being conveyed to the bridge along service railways, which conducted to a gangway erected across the valley in connection with the centering. From this gangway they were removed to their positions by means of travelling cranes, stretching across the whole building. The centering was erected in four stages, each stage being proceeded with as the building advanced, and consisted of whole logs of memel, placed one above another, and properly connected, at each stage, with cross ties and diagonal braces, and well secured by bolts, &c. The quantity of timber used was about 50,000 cubic feet, and of iron about six tons. The work was commenced in November, 1845, the great arch was keyed on 8th April, 1847, and the last stone was laid on 14th March, 1849; the building being completed within three years and four months from its commencement. The number of men employed averaged about 400; and, to the credit of Messrs. Ross and Mitchell, the contractors, and Mr. Fulton, their superintendent, not a single serious accident occurred during the execution of the work. During its progress, it was visited by vast numbers of people from all parts of the country, attracted by the beauty of the scenery and the grounds, as well as by the interest attached to the operations which were going forward. The quantity of stone used in the viaduct was about 530,000 cubic feet, and the total cost of the work was about £41,000.

"On a Self-Acting Apparatus for disconnecting the Carriages from the Tender, upon the Engine leaving the Rails." By Thomas C. Gregory, Esq., C.E.

The author stated that, as expressed in the title, the object of the invention is to cause the engine, by the mere motion of quitting the rails, to disengage the carriages without any shock, and leave them in safety behind. That this is effected by means of a lever running below the engine and tender along the centre, having one end fixed at the front of the engine, and the fulcrum at the fore part of the tender. This lever acts on a box placed at the back of the tender, to which the carriages are attached. The lever is a strong bar of T iron, hung from the fore part of the engine by an iron rod, which has a rounded nut attached, on which the lever may turn easily when it changes its direction on coming on to a curve. There is a provision made for the separation of the engine and the tender, and for the play between them. At the fulcrum, and at necessary parts, the lever is supported by iron trays. The box, which is of cast-iron, is fixed firmly in a space cut out of the back-board of the tender, and is kept in position by a strong vertical iron bar. It has a strong iron rim, with an opening at one part of sufficient width to allow of the carriage hook falling out, when required to do so, without tension. There is a spring within, having one end fixed firmly on the vertical iron bar, which is immoveable, and the other end fixed in the side of the box. In order to charge the instrument, the box must be turned in opposition to the spring, till a protuberance on the side rests against the end of the lever, and the latter being made a rigid body by connecting the engine and tender, the box is kept in position. The carriage hook is then attached, and the engine starts with its train. As long as the engine keeps the rails on a straight line, or on a certain amount of curve, to be hereafter mentioned, the box retains its place; but immediately on the front wheels of the engine deviating to a certain extent to either side, the lever slips past the protuberance, and the spring recoiling, the box returns to its original position, when the hook falls out, and the carriages are disconnected. It may be said that the hook may fall out when not required to do so, but this may be prevented by attaching a heavy weight to the middle of the chain, so that as it slackens it may fall, and thus retain the hook in its place; besides, a slight inclination upwards from the hook to the opening is provided, so that as the box is acted on by the lever on curves, no tendency may be given the hook to slip out. It has been calculated that a single lever will produce the nicety of action that is desirable only to the extent of a half-mile radius curve, and this has been adopted as an extreme, so as to simplify the explanation, and show the principle as clearly as possible; but by reducing the length of the back arm, and substituting a short lever of certain proportions, nearly the same degree of nicety may be produced, taking a quarter-mile radius curve for the extreme. This is perhaps the sharpest used on main lines of railway, and when they do occur, the train goes so slowly, that there is no fear of any accident. There are sharper curves leading into engine sheds and stations, but as there is no necessity of the apparatus being used then, the carriage may be attached to a loop fixed in the buffer frame. It has been calculated that on a half-mile radius curve the front of the wheels must be two inches off the rail; on a mile curve only three-fourths of an inch off, and on a straight line still half an inch on the rail to start the machine. Before the engine attains this distance of 2 inches, there is little fear of the tender wheels being off the rails, for it is neither more or less than a circumstance that occurs every day in the case of an engine and tender passing on to a curve, when the fore part of the engine is on the curve and the tender on the straight. If the tender were to come off instead of the engine, the apparatus is expected to act. There can be little fear of the box being released by any lateral motion of the engine; for when on a straight line, the end of the fore-arm must be 2½ inches to the one side or the other ere the apparatus will work. This can never be without the engine leaving the rails. While on a curve, the engine goes very steadily on account of the pressure on the outer rail, and the tendency is to diminish the angle made; and if it were to slip down to the lower rail, a sufficient allowance is made in the calculation. As the idea is perfectly novel, the invention was most respectfully submitted to the consideration of the Society; and if it be approved of and adopted, the additional safety insured to the public will be very great.

"On a Pressure-Indicator for Locomotives, and other Steam-Engines." By Mr. J. S. Fraser, engineer, Great Western Railway, Swindon.

The author stated that the principle or law on which the action of this indicator depends was first made known through the experiments of M. Clement Desormes, "who showed that when steam, under high pressure, is allowed to escape from an orifice pierced in a plate, and a flat disc is brought close to this plate, the plate and disc are made to adhere together." That this principle, with a lever of the first order connected by a link to the disc, the disc resting on a plate, having a small hole through it and the short pipe (screwed at the end, for the purpose of fixing to the top of guage glass, or other part requiring to be tested), along with a weight or spring balance, complete the instrument. The author stated that it would be obvious that the piston indicators and manometers are open to many objections; the first, from friction and unequal expansion, never works freely, and the last, requiring a correction for the temperature of the air, is not such as can be of practical use. That all safety valves on steam boilers should be tested, as great errors exist in this, and nearly always this error is in excess of pressure; and that to detect "wire-drawing," or a less pressure in the cylinders than in the boiler, &c., &c., such an instrument should be used in preference to one liable to stick at any point, and give doubtful, if not incorrect, results.

April 8.

"On a Machine for Boring Coal." By Mr. Alexander Cleugh, London.

The principle of this machine consists in an application of the screw augur, for making the bores in coal for blasting, instead of the former method of jumping by means of a sledge hammer and boring bar. The advantages were stated to be—1st, In the greater ease and speed with which the operation can be performed. By the ordinary mode of jumping the bores, it was stated that two men are employed in a confined and fatiguing position, one wielding a heavy hammer, and the other holding and turning the boring bar, both of which operations require the application of great force and strength, whilst the men are in a sitting or kneeling posture, unable to exert it with freedom. By this machine, one man can place and work the machine with the utmost freedom, and make the bore in one-fifth of the time taken by the former mode. 2d, In the greater certainty and safety in the operation of blasting by means of the bores made by this machine, on account of the uniformity or regularity of the bores. The bores made by the former method were said to be often very irregular, and wider at bottom than top, which frequently causes the charge to be driven out in exploding, and a new charge rendered necessary; and recharging is always attended with danger, from ignited portions of the packing which may be left in the bore. 3d, In the less danger in which this method can be applied in boring coal contiguous to "old workings." In the former method it was stated that a much larger hole is made, by which the water from "old workings" often breaks through, causing great destruction to life and property. The bore made by this machine is small, and can easily be plugged up, thereby preventing such destruction and loss of life.

"On an Improved Boiler for Locomotives." By Mr. James Fairbairn, New Swindon, Wilts.

The author stated that, in this arrangement, the cylindrical part of the boiler is proposed to be nearly filled with tubes, thus increasing the heating surface very considerably. The steam chamber on the top of the boiler runs all the length of the cylindrical part, and can easily have the same contents of steam room as is generally given. The steam pipe runs through this steam chamber, and along its whole length, having slot holes cut in its upper surface for the passage of the steam to the engine. It will be free from water causing priming, which is rarely the case in engine boilers hitherto made. This, with the increased heating surface (about 1,400 feet), will be of great importance. The cross section of such a boiler will be like the figure 8, only the steam chamber is small in proportion to the cylindrical part of the boiler containing the tubes. It joins the fire-box front, which is eccentric, to the cylindrical part of the boiler. It is on the arched principle, and does not require a dome-shaped top on it.

"On an Improved Method of Constructing Wire Fences." By Mr. James Smith, smith, Lawhill, Trinity Gask.

It was stated that the object of this plan is to increase the simplicity and facility of the construction of wire fences, and to afford easy means of correcting the occasional defects of over tightness or over slackness of the wire lines, whether arising from faults in the construction, or from the vicissitudes of temperature: that this is effected by mounting the straining posts with rollers and ratchet wheels for the wires, by which, with tools of the most simple kind, an ordinary labourer can erect the fence and stretch the wires in the most perfect manner; and the wires, when becoming too slack or too tight, can be easily corrected, so as to keep them always in a perfect state: and that the expense of obtaining these advantages very little exceeds that of constructing the fence on the common method.

Referred to a committee.

"On a Description of Railway Points and Crossings—the Setting of the Rails in the Chairs, with a Model of a Switch-Rail." By William Campbell, Esq., C.E.

In this paper Mr. Campbell proceeded to describe a sketch of railways, sidings, &c., showing the positions of the points and crossings, working drawings of the switch and stock or fixed rail, and the crossing rails as executed on the Edinburgh and Bathgate railway, full size cross sections at the points of the model, the common and the patent switches, showing the different methods of leading off one rail on to another, the position of the rail in the chair, &c. The improved switch, of which a full-size model was shown, is on its bottom side the same as the common make, while on its top side it resembles the patent switch, but is simpler to make, is equally efficient, and will stand more fatigue. He had made a careful examination of the points on the principal lines, and observed their great tear and wear; therefore, in the model the bearing surface is neither notched nor under-cut, the inside of the top of the switch being bent with a twist so as to pass under the top flange of the stock rail. The top of the switch not being mitred into the under side of the bearing surface of the stock rail, it is not liable to be locked by the barbing over of the stock from the pressure of the wheels, as happens to the general make of the patent switch, and others which resemble it, in cutting under the top flange of the stock. A cut of rail, rusted and varnished on the end, showed the laminated structure of the top of the rail, which is the part that gives way under traffic by scaling off, from the constant impact of the wheels. This is kept in view in the make of the improved switch. The cutting away part of the underflange of the stock, while it does not materially weaken it, allows a broader and steadier base for the switch, and stones will not so readily rest between and prevent the shutting of the switch. The drawings showed how the common make of switch possessed the advantage of a straight face and continuous bearing surface, in great perfection, although, from consisting of two parts, is much less durable at the point than the model. The author was not aware of anything having been done to meet the tear and wear of the crossing point, notwithstanding the weight of the engines in use: any contrivance for the main road must be very secure, but at stations where there is much traffic, while the transit is slow, the wheels might be assisted over the interval at the crossing point by a piece of iron keyed between the rails, having its surface one inch below the top of the rail, and tapering down at each end, on which the flange of the wheel would run till the face again touched the rail, and so be prevented from falling, as it does, off the steeled point with a blow on the knee of the wing rail, which is the point that gives way. This is similar to what is done at the crossing of the bars on a turntable. The chair is laid level on the sleeper, but the seat of the rail is inclined 1 in 15 in the chair, so as to give the rail an equal cant its whole length, to meet the cone of the wheel. The inside jaw of the joint chair should fit close up under the flange of the rail; but the intermediate chairs should not rise quite so high, and be slightly rounded on the inner face, to allow the rail to adjust itself to the joints, which are first keyed and spiked firm.

"On a Triple-Acting Electro-Chemical Telegraph." By Mr. R. Smith, chemist, Blackford.

In this paper the author vindicated his claims as the original inventor of the electro-chemical telegraph, which was communicated to this Society in 1843. He then described his triple-acting electro-chemical telegraph. In this telegraph, a ribband of cotton, or paper, wet with a chemical solution, is made to pass over a leaden plate by means of clock-work, and an arrangement is placed upon the ribband over the leaden plate for printing the telegraphic characters. The impress apparatus is made of platinum, which produces the indications with greater facility than iron. The communications are transmitted from a distant station by means of keys similar to those employed by Mr. Smith in his former instruments. One of the greatest objects accomplished by this invention is, that it will transmit three different communications at one and the same time, so that by this telegraph the inconvenience so much complained of, viz., communications being thrown off the wires, to give place to those of greater importance, will be completely obviated. The author stated that while the expense of construction will not be nearly so much as that of the electro-magnetic telegraph, it has only three communicating wires, and will transmit three times as much information as the telegraph in present use.

April 22.

"On a New Method of inducing an Upward Current in the Upcast Shaft of Coal Mines, to promote Ventilation." By Mr. J. Seton Ritchie, Edinburgh.

The author adverted to the vast numbers, as workers and dependants on them, interested in the adoption of means by which freedom from danger in coal mines may be attained; then, mentioning the theories by which mine explosions are accounted for, he noticed the numerous methods which have been proposed for maintaining mines in a state of safety, and particularly the method in general use of inducing an upward current of the air of the mine by means of a fire at the lower part of the upcast shaft; that, as the provision of a separate shaft for the removal of the air of the mine is prevented by the great additional expense, even though mechanical appliances may appear highly calculated to maintain a powerful and steady current, difficulty exists in their application, as interfering with the free working of the produce of the mine carried on by the upcast shaft, which is further increased in making provision for continual reliance on them, as spare appliances would require to be provided. The author stated that the method now proposed is free from this obstacle. The current is induced by means of pipes heated by water circulating in them, fixed round the circumference of the shaft, in such manner, within the line of it, as shall shield them from injury, leaving sufficient exposure of them to communicate their heat to the air in the shaft; the furnaces for heating the circulating water being at the nearest convenient distance, at a considerably lower level than the orifice of the shaft, as on the depth at which they are placed will depend the perpendicular extent of the upper part of the shaft around which the pipes may be placed. Certainty of action could, with ordinary caution, be relied on, as, even if one of the circulations ceased from any cause to act, the others would during that time continue in action. A similar application might also be made at the lower orifice of the shaft, and even extended in some measure to the workings; or the fires now in use at the foot of the shaft might be retained, and the application alone made at the upper part, in order to promote greater certainty and steadiness in the current. It was submitted that a similar application might be made of steam as of water. It was pointed out that the maintaining of the upward current in the shaft is but one section of the keeping the mine in a state of safety—that, though this will never be effected without a steady and powerful extracting current in the shaft, the latter will be of little avail, unless accompanied by carefully laid out air-courses throughout the mine itself, properly modified as the working advances, attention on the part of those appointed to open and close the doors which it becomes necessary to erect in them to direct the currents, and attention that the building off of exhausted sections of the mine be as frequently as possible accomplished, that they may not become next to permanent reservoirs of noxious gases, ready to lend their aid to a general explosion.

"On a Design for a Water Meter." By Mr. F. A. Bucknall, New Swindon, Wilts.

The author stated that the object of this meter is the measurement of the supply of water to private dwellings, breweries, &c. It consists chiefly of a fan-shaped bucket-wheel, revolving within a cylindrical case, and kept water-tight by means of packing, made of India-rubber, leather, or other elastic substance, supply and delivery pipes, and wheel and pinion gear, which is connected with an index plate. The revolving action of the meter is maintained by the gravity of the wheel being constantly greater on the one side than on the other, owing to the continuous running off of the water from the opposite side to that at which the water is supplied. This meter is only in action during the time the water is running off.

"On a new Liquor-pump, calculated to prevent the liquor from being contaminated with verdigris and oil in the interior of the Pump-barrel, also applicable to the pumping of Acids," by Mr. Hay Dall, brassfounder, Glasgow.

The author stated the following as the disadvantages of the present system of pumping liquors: 1st. That each liquor requires a separato pump. 2d. That the liquor, in passing through the barrel of the pump, corrodes its interior, especially in the case of fermented liquors, thus producing constant decay in the barrel and valves, and also an accumulation of verdigris in brass pump-barrels, which, together with the oil or tallow used to lubricate the piston, is constantly mixing with and contaminating the liquor. The inventor stated that he had his attention frequently directed to the disgusting state of the interior of the corroded pump-barrels which had been sent in to repair—that, generally, every crevice and corner of the piston and barrel where it could collect, was clogged with a poisonous and nauseous compound of stale beer and oily verdigris, ready to mix in greater or less quantity with the next liquor that would pass through it—that, in the new method, one pump can be made to supply any number of liquors, while the liquor never gets into contact with the pump-barrel. The pump is used solely as an air-pump to withdraw the air from the interior of a series of glass or earthenware vessels, properly arranged, and made to communicate with the liquor casks by tubes immersed in the liquor. When the cocks are properly arranged, and the pump is worked, the liquor rises and fills the vessel, never having passed through the pump-barrel at all, and when the vessel is full the pumping is stopped, and the liquor is run off into the vessels from which it is to be drunk, by a common cock. All the liquors may be pumped up at one time, or any one separately, by properly arranging the cocks; or any one may be pumping while another is being run off. The author stated, that he intends this pump also to be used for acids and other corrosive liquids, where the very troublesome leaden pumps are now used. The pipes in this case would be made of lead, porcelain, or glass.

"On a Safety-strap for Glaziers and Slaters," by James R. Dymock, Esq.

It was stated that this apparatus has for its object the safety of tradesmen who are employed on roofs, or outside of windows, &c. It consists of a balanced iron rod secured inside the window, a strap with shoulder-pieces, and connecting cord or rope, each being of sufficient strength not only to sustain the weight of a man, but to endure a sudden jerk without breaking. Its advantages were stated to be, simplicity of construction, cheapness, portability, and readiness of adjustment; and that the application of the apparatus might be familiarly illustrated by the ordinary well-known method of securing a watch-dog's chain.

"Description of three Drawings of—1. A Grate, in the Victorian style. 2. A Candelabrum, in the Arabesque style. 3. A Gas Lustre, in the Flemish style," by Randall Dale, engraver, 5 South College Street, Edinburgh.

The following were stated to be the peculiarities of these drawings, viz.: Grate—brass ornament on bright steel. Style, Victorian; a style invented by the draughtsman, the first drawing of which was that respectfully submitted to the Society. Candelabrum—silver or brass, five lights, top of front leg not drawn, in order to show the junction of ornament at centre. Style, Arabesque; a rich Italian branch, grotesque in its formation, which constitutes its character. Gas Lustre—brass, with shears, pulley, weight, &c. Style, Flemish; in which is combined the angularity of the Elizabethan style and the richness of the Italian, &c. Detteslins Flemish ornaments.

MONTHLY NOTES.

GUTTA PERCHA.—When, in 1845, we penned our first remarks on the discovery and promising usefulness of this extraordinary substance, our furthest conceptions left us very far short of an adequate notion of its ultimate value. We meet with it everywhere, and no class is more beholden to it for economising time and labour, than the constructive artists to whose interests this *Journal* is devoted. The *Weekly Chronicle* thus smartly hits off the story of its modern manufacture and uses:—"Wharf-road, City-road, where the gutta percha works are situated, is one of the busiest localities of London. It runs along the Grand Junction Canal, about midway between the Eagle in the City-road, and the Angel at Islington, and seems to have some especial attraction for patentees—for almost side by side stand patent sawing mills, patent planing works, Brett's patent bottle capsule manufactory, patent fire-wood works, and the extensive premises of the patent gutta percha company, the tall chimney of which seems more for ornament, or a guide to the works, than any other use, as but little smoke is ever seen above it. Nevertheless, it is the chimney of two sixty-horse boilers, made by Galloway, of Manchester, under a recent patent, and which evaporates 11 lbs. of water to the 1 lb. of coal, and effects such complete combustion as to prove that great clouds of smoke are not essential to manufactures. These boilers work two very powerful, and a little auxiliary steam engine, which drive the whole machinery of a large and busy factory, employing from 120 to 150, and on occasion, 200 hands, men and boys, skilled and unskilled, which pays some £10,000 a year in wages, and works up into an almost endless variety of shapes and articles, useful and ornamental, some thousands of cwts. annually of gutta percha, finding profitable employment for shopkeepers and dealers in every town, and almost village in the kingdom, giving a new impulse to industry amongst the natives of the Malay peninsula, the islands of Singapore, Sumatra, Borneo, and the entire range of wooded islands from Sumatra to the Philippines; bringing designs of artistic excellence, and articles of ornament, usefulness, and taste, within the reach, through the simple magic of cheapness, of multitudes, and giving a new direction to applications of machinery and skill of invention. The tall chimney of the gutta percha works is, therefore, important in marking the rapid rise of a new article of commerce and a new manufacture. In the yard are several stacks of raw gutta percha, in lumps, from the size of a flitch of bacon to large paving-stones, and very much the colour of new leather. The first process of manufacture is the cleansing of the material, to accomplish which, it is cut into slices, boiled, rolled, torn to pieces, dropped into cold water, and after due settling there, the pure material floating on the top, is skimmed off, and the refuse, for which as yet no good use has been discovered, thrown away. The slicing is accomplished by a wheel of solid iron, eight inches in thickness, and about the size of the wheel of a large waggon or water-cart, fitted with slantingly-projecting knives, like the cutter of a spoke-shave. The wheel runs round at the rate of about two hundred turns a minute, and having three knives, shaves the gutta percha, which is forced up close against it, at the rate of 600 cuts a minute, into slices like thin pieces of collared brawn. The steam which drives the slicing-wheel and sets all the other machinery of the factory in motion is conveyed to the vats and does the boiling. A considerable amount of the impurities is left in the boiling-vats, and the rolling and tearing is managed by pressing the hot mass, which is about the consistence of a very tough dough, into a hopper, at the bottom of which, two small rollers seize hold of it, roll it between them, and pass it on to a larger roller set with rows of jagged teeth like rakes, or a saw with the teeth turned down, and which, whirling at the rate of 800 turns a minute, tears up the gutta percha into little shreds like tan in a tan-pit. After the cold water purification the material is again warmed to about 180° to 200°, and, in soft masses about the size of an ordinary three-foot bed-bolster, and looking very like soft cobblers'-wax, it is locked up in the kneading machines, the purpose of which is to force out all air and water, and to make the gutta as smooth as well-mixed paste. These kneading machines, of which sixteen or eighteen are ranged side by side in a double row upon the floor, are very thick, strong, round, iron boxes, about three feet long, and a foot and a half deep. Inside each box turns round a ribbed iron roller, leaving but little room between itself and the sides of the box. The lid of the box, fastened by very strong hinges and bolts, has two good sized holes in it for the escape of steam and air. When the box is packed, and the lid down, the ribbed roller presses the gutta percha with great force against the sides, so much so that the bolts are sometimes forced and broken. In these machines the gutta percha is rolled and kneaded at a temperature not below 180° for not less than four hours, and it is then in a fit state for the future purposes of manufacture, whether to be rolled into sheets, to be moulded, stamped, or fashioned into all the hundred varieties of articles for which it has been already brought into use, or to be made into cord or tubing. In the form of sheeting of various widths and thicknesses, it is most readily applicable for several purposes. It is so formed by being passed between two rollers of the requisite width, which answer the purpose of the cook's rolling-pin with paste, and which regulate the thickness by the space between them. From the rollers, the soft sheet is carried along by a revolving band of india-rubber or gutta percha cloth, tightly stretched, of about 50 feet in length, which rolling over a drum at the end, carries back the sheet the whole distance again with the other side up. By this time the sheet is cool and hard, and is rolled round a drum until the required length is attained, when it is cut, the drum removed, and another put in its stead to wind up the next length. When the sheet is of too great a thickness to become cool in merely travelling the distance, it is blown upon as it passes by a fan, like that of a winnowing machine. In connection with the rolling machine is a very simple contrivance for cutting the sheets into bands of any width, from that required for a shoe-sole, or an engine band, to harness straps." Another most extensive manufacture is that of tubes, which we cannot just now stay to describe. Of the curious applications of these tubes, a good example was given in our "monthly notes" for July; a large farm being supplied with liquid manure through their agency. The variety of purposes to which it may be judiciously applied, is so immense, that it would be a fruitless task to attempt to follow them. They constantly increase. Amongst the very latest, is Mr. Auchterlonie's ingenious mode of ornamenting fabrics described in the present pages.

HOW'S SALINOMETER.—Mr. A. P. How, an engineer in the United States' navy, has recently patented a new arrangement of salinometer, intended to show at all times the exact degree of density of the water in the boiler, independently of the internal steam pressure. The instrument consists of a vertical cylinder, placed in any suitable position near the boiler, so as to be in constant view of the engineer. The bottom of this cylinder is in communication by two passages at its lower end, with both the upper and lower strata of water in the boiler, and contains within it a floating hydrometer with a graduated stalk. It is also fitted with a thermometer and an overflow-pipe. Ocean water holds in solution about one pound of salt to every thirty-two pounds of water; thus, when one-half the water is evaporated, there is one pound of salt left to sixteen pounds of water. If half of this water again is evaporated, then the proportions of salt and water will be as one to eight, or four to thirty-two, or what is marked 4-32 on the hydrometer. It is on this principle that the hydrometer is graduated, 0 being the mark for fresh water, and each division, from 1-32 to 2-32, being subdivided into halves and quarters. It is also graduated for the temperature of 200 degrees, it being necessary to have some standard of temperature at which the indications were always to be taken, as steam of different pressures has different temperatures; and as a difference in temperature will alter the indications of the hydrometer, it is therefore necessary that the water be relieved from the pressure in the boiler, that it may assume a uniform temperature. This it does under the pressure of the atmosphere, as accomplished in this instrument, which renders it applicable to boilers where the pressure of steam may vary, or where either high or low pressure steam is used. During working, one of the passages is open, to admit a flow of water from the boiler into the cylinder, the pipe leading into the latter, opening into the boiler about the level of the tops of the furnaces. A constant stream of water thus passes through the salinometer, the density in the latter being at all times equal to that of the water in the boiler. The temperature of the water is constant

at about 200 degrees; or, if it should vary, the partial adjustment of the stop-cock affords the means of regulation to this point. Every ten degrees in temperature will vary the indication of the hydrometer one-eighth of 1-32; 200 degrees being the standard—therefore if it is ten degrees above 200, it will show one-eighth of 1-32 less dense than the true density; and for every ten degrees below 200, it will indicate one-eighth of 1-32 more than the true density: thus, if the temperature is 210 degrees, and the hydrometer indicate a density of 2-32, the true density would be two 1-8, and if the temperature is 190 degrees, and the hydrometer indicate 2-32, the true density is one 7-8 of 2-32; but if the stop-cock is properly regulated, no correction will be necessary, as the proper temperature can easily be produced by opening it more or less. There is then a constant in-flow from the boiler, and an out-flow from the cylinder, of water of the same density as that at the part of the boiler whence the supply is taken, and this density is shown on the stalk of the hydrometer. The contrivance is ingenious, as the attendant is at once put in possession of the exact density of the water in his boiler, without reference to the pressure within.

Wrought-iron for Wire Making.—Wire-iron should be strong, hard, and tough. That which is fibrous, but not strong, is of no use; the wire made from it will be rotten, and without lustre. Where fibrous iron is employed for this purpose, the fibres must be very fine, and the colour of the iron white. If the iron is bright, coarse fibres make rough scaly wire; but if it is fibrous, and of a dull colour, the wire will be both rough and rotten. Iron rendered cold-short by silex or phosphorus is not adapted for wire manufacture; but, when rendered cold-short by carbon, it will form, for this purpose, the most advantageous material available. Iron which is hot-short on account of sulphur is very apt to break in drawing. That which is hot-short in consequence of a deficiency of impurities is a still worse article. Very pure iron is so weak that wire cannot be made from it. The strongest kind of wire is made from an iron which contains just sufficient copper to make it decidedly hot-short. Wire-iron must be very uniform in its aggregate form; that is, the billets from which wire is to be drawn must have a uniform texture throughout. It must not be a conglomeration of fibrous iron, cast-iron, and steel. It requires dextrous workmen to make a good article even from excellent metal. The Catalan forge is not adapted for this purpose, even though the iron should be the product of the best of all materials; it does not work with sufficient regularity. White coke or anthracite metal will not make wire-iron, even with the greatest attention, and in the best charcoal forge. Very nearly the same may be said of hot blast and white charcoal metal, smelted from the poorer ores of the coal formation, and bog ores. White metal from the rich magnetic ores of New York, New Jersey, and Missouri, answers excellently, if carefully worked in a charcoal forge. The best wire-iron is made in the puddling furnace, from cold-short gray charcoal pig, or from any gray pig-iron, whether charcoal or anthracite, provided the metal is of such a quality that no difficulty results from boiling it. Neither the best nor the inferior qualities of white metal, will make good wire-iron in the puddling furnace. Iron of fine grain, or fine fibre, of uniform texture, great lustre, and of a somewhat bluish colour, and soft as well as very tenacious, is that upon which our principal reliance must be placed. From this, it is evident that wire-iron may be most profitably made in puddling works where boiling is well managed. In such establishments, the finest and strongest rough bars may be reserved for wire-iron. A selection may be more safely made from billets than flat bars; and cold-short is to be preferred to fibrous iron.—*Overman on Iron.*

On Determining the Capacity of Vessels.—Mr. Pook, naval constructor at Charleston, Mass., has discovered an ingenious mode of determining the capacity of vessels; and its approximation to the actual displacement of government and ordinary freighting ships renders it valuable; its ready application to such vessels as have had their displacement calculated, will enable the reader to test its accuracy. Adapted, as it is, to almost all descriptions of freighting vessels; very sharp vessels, and particularly our sharpest ocean steamers, are exceptions to the general rule, having a smaller displacement than the rule would give, owing to their having no dead rise, and an easy bilge. The rule is as follows: From 90° deduct the angle of the floor, or the degrees of dead rise; multiply by .0075 the quotient is the decimal for capacity—multiply the length by the breadth, and that product by the depth, from the bottom of the garboard to load-line, and the last product by the decimal of capacity, and divide by 35, the quotient is the capacity in tons. Thus assuming a ship to be 160 feet long, 35 feet wide, and, from the bottom of the garboard to load-line, 14 feet deep, with four degrees of dead rise, we have—

$$\underset{\text{Exponent.}}{90° - 4°} = 86° \times \underset{\text{Decimal of Capacity.}}{.0075} = .645 \qquad \underset{\text{Length.}}{160} \times \underset{\text{Breadth.}}{35} = 5600 \times \underset{\text{Depth.}}{14}$$

$$= 78400 \times .645 = 50568 \div \underset{\text{Cubic feet per ton.}}{35} = 1444 \text{ capacity in tons.}$$

The principal, and, perhaps, the only difficulty in applying this rule as a standard of measurement, is its liability to evasion (which is the most objectionable feature in the present law). The load-line could not be marked a proportionate distance from the base-line, or from the plank-shear, without exposing the law to the same amount of infractions the present one is. But, as a ready rule for general reference and approximating the truth, Mr. Pook's rule is, doubtless, without a rival. After the actual displacement has been found, a very convenient method of obtaining the capacity will be found in the following: Multiply the length between perpendiculars by the breadth, that product by the depth from base to load-line, this last product divided into the whole displacement, and the quotient will furnish the exponent of the ratio of capacity, and will apply equally well to all descriptions of vessels.—*Marine and Naval Architecture.*

Jobson's Patent Stove Grate.—The circular radiating stove grate introduced by Mr. Jobson, the eminent grate-maker of Sheffield, and recently exhibited at Mr. Cubitt's conversazione, is at once one of the most elegant and philosophical of heating contrivances. The reflector—an inclined annular surface—surrounds the entire grate, and throws off every particle of the heat of the fuel; and the reflecting surface itself being cool, the heat thrown into the room carries with it none of that harsh sensation which arises from the baking of the air. The ash-pit is entirely concealed—which arrangement, whilst it improves the appearance of the grate, does away with the housewife's mortal enemy—dust. The curve or angularity of the reflector is variable, to meet the size of the room; and the reflecting surface is moveable backwards or forwards at pleasure.

Mulberry's Improvements in Slide-Valves.—Assuming that the injurious grooving action in steam-engine slide-valves arises almost entirely from the frequent detaching of small particles of metal from the edges of the ports, a Mr. Mulberry, of Pennsylvania, has patented the rounding or flattening of the edges of the ports, to prevent the breaking any of the metal. There is little doubt but that injury does frequently arise from this cause; but the bad effects are slight in comparison with those resulting from the presence of foreign matters on the valve-faces, combined with the rush of high-pressure steam when leakage once occurs.

Kesterton's Amempton Carriage.—We have before us a couple of views of a new carriage, the "Amempton," just introduced by Mr. Edwin Kesterton, the eminent carriage-builder of Long Acre, London. The inventor's object has been to secure the important desideratum of an open and close carriage in one—that is, to produce a perfect carriage of either kind, without involving the several inelegancies of construction to which we are accustomed in all previous combinations of the kind. The illustrative sketches represent the carriage under both forms—open and closed. The open vehicle is remarkably light in appearance, and presents all the elegancies which the class ought to possess; whilst, when closed, it partakes of all the stability and comfort to be found in the most complete arrangement of the closed kind. Without the assistance of the sketches themselves, we cannot explain the precise details of the transformation, but we can vouch for its being accomplished without the slightest difficulty.

Universal-Jointed Castors.—We lately saw in Birmingham some specimens of a very clever and very much wanted improvement in furniture castors, which are certain to supersede the clumsy expedients now in use. In the common castor, the two movements of the supporting roller and the spindle have scarcely any connection with each other; and as the eye of the roller is bent out very considerably, we invariably meet with an unpleasant checking action, whenever the table is to be moved at any angle different from that at which it has previously come to rest. The new castor has been patented by M. Chaufforier of London, and its merits consist in the substitution of a spherical piece of metal in place of the plain roller. The ball is formed out of two hemispheres placed together, with a disc of metal between them. Two journals are formed on the edge of this disc, diametrically opposite to each other, to fit to a pair of eyes formed in the ends of two branches on the spindle of the castor, which branches take in the ball between them. A central spindle, passing diametrically through the ball and through the centre of the disc, forms, in its bearing in the latter, a second centre of motion, so that the spindle, by which the whole is connected to the article of furniture, being screwed up firm, an easy movement is obtained in any direction, by the joint action of the two spindles, as in the common universal-joint.

Patent Law Reform.—At page 129 of our 2d vol., we gave a synopsis of the report of the Government commission upon the patent laws, with some practical remarks upon it. We are now happy to find that a bill has been introduced into Parliament for the purpose of effecting some very important reforms. The bill provides, amongst other things, for the abolition of the privy seal and signet offices; that the 18th Henry VI., which enacts that letters patent shall not bear date prior to the delivery to the Lord Chancellor of the warrant for the grant shall be repealed; and that the Lord Chancellor, or Keeper of the Great Seal, and the Secretary of State, may make further alterations in the mode of passing letters patent. Should the bill be allowed to pass in this form, we have little doubt that many very important alterations will be made by the Lord Chancellor. The defects of the present system are so glaring that it will be impossible for him to exercise the very important power about to be placed in his hands, without effecting great benefits to inventors. We trust that, for the protection of poor inventors, there will be some preliminary protection allowed. As at present, the poor man who has to obtain the assistance of a capitalist, is compelled to disclose his schemes before the letters patent are obtained—a proceeding which places him in a very dangerous position, and often robs him of the entire benefit of his discoveries. We shall watch the progress of the bill with considerable anxiety, and we trust that we may, in our next number, report something more definite upon the subject to our readers.

The Recent Deaths of Eminent Men.—Death has latterly made fearful inroads upon the men of the day. Sir Robert Peel, his Highness of Cambridge, Timothy Hackworth, and Robert Stevenson—all are departed since our last issue. The daily prints have rung with the praises of the two first—the latter may more fitly have a tribute paid to their memory in pages like ours. They were both "full of years and honours."

ENGLISH PATENTS.

Sealed from 24th June, to 17th July, 1850.

Robert Andrew Macfie, Liverpool, sugar refiner,—"Improvements in manufacturing, refining, and preparing sugar, also improvements in manufacturing and treating animal charcoal."—June 24th.

Henry Stephens, Stamford-street, Blackfriars-road, writing fluid manufacturer, and Edwyn Wylder, Paddington, Middlesex, mechanist,—"Certain improvements in ever-pointed pencils, pens, and penholders."—24th.

William Laird, Liverpool, merchant,—"Improvements in life-boats, and in apparatus for filtering and purifying water."—(Being partly a communication)—24th.

Joshua Vickerman Binns, Lockwood, near Huddersfield, York, mechanic,—"Improvements in piecing wool cardings, and in a machine called a piecing machine."—24th.

Edward Mitchell, Great Sutton-street, Clerkenwell, gentleman,—"Improvements in fastenings for articles used for writing and drawing, and other purposes, and improvements in articles to be used for writing and drawing."—24th.

John Percy, Birmingham, doctor of medicine, and Henry Wiggin, of the same place, manufacturer,—"A new metallic alloy, or new metallic alloys."—24th.

Thomas Fulljames, Old Kent-road, gentleman,—"Certain improvements in machinery or apparatus for raising, lowering, and moving weights, or other heavy bodies."—26th.

James Forster, Liverpool, merchant,—"Improvements in filtering water and other liquids."—27th.

Joseph Foot, Spital-square, Middlesex,—"Improvements in bolters."—27th.

William Lancaster, New Bond-street, Middlesex, gunmaker,—"Improvements in the manufacture of fire arms and cannon, and of percussion tubes."—July 3d.

John Coope Haddan, Bloomsbury-square, Middlesex, civil engineer,—"Improvements in the construction of carriages and of wheels, and in brickwork."—3d.

Francis Edward Colegrave, Esq, Brighton,—"Improvements in the valves of steam and other engines, in causing the driving wheels of locomotive engines to bite the rails, and also in supplying water to steam boilers."—3d.

Charles Phillips, Bristol, engineer,—"Improvements in apparatus or machinery for cutting turnips and other similar substances as food for cattle."—3d.

Richard Hornsby, Spittlegate Grantham, Lincoln, agricultural implement manufacturer,—"Improvements in machinery for sowing corn and seeds, and in depositing manure in thrashing machines, in machines for depositing or winnowing corn, and in steam engines and boilers for agricultural purposes."—3d.

James Thomson, Glasgow, civil engineer,—"Improvements in hydraulic machinery, and in steam engines."—3d.

Richard Winter, New Cross, Kent, gentleman,—"Improvements in metallic vessels for measuring and holding liquids."—3d.

James Ward Hoby, Blackheath, engineer,—"Certain improvements in the construction of parts of the permanent ways of railways and in shaping iron."—3d.

Paul Rapsey Hodge, civil and mechanical engineer, Adam-street, Adelphi,—"Improvements in certain descriptions of steam engines, and in the apparatus and management for cultivating and manuring the soil, and in treating the produce thereof."—(Communication.)—3d.

Wakefield Pim, Kingston-upon-Hull, engine and boiler maker,—"Certain improvements in the construction of the boilers and funnels of steam engines."—3d.

Charles Starr, New York, in the United States of America,—"Improvements in bookbinding."—3d.

James Kingsford, Esq., Essex-street, Strand,—"Improvements in refrigerating and freezing."—3d.

Weston Tuxford, Boston, Lincoln,—"Improvements in machinery for crushing or pressing land, and for shaking straw; also, improvements in applying steam power to agricultural machinery."—4th.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in the preparation and manufacture of caoutchouc or India rubber."—(Communication.)—9th.

Robert Rumney Crawford, Warden Paper Mill, Northumberland, paper-maker,—"An improvement in drying paper."—10th.

Jacob Connop, Hyde Park, Middlesex, gentleman,—"Improvements in melting, moulding, and casting sand, earth, and argillaceous substances for paving, building, and various other useful purposes."—10th.

James Hill, Staleybridge, Chester, cotton-spinner,—"Improvements in or applicable to certain machines for preparing cotton, wool, and other fibrous substances for spinning and doubling."—15th.

Tempest Booth, Ardwick, Lancaster, gun manufacturer,—"Certain improvements in the method of and apparatus for obtaining and applying motive power."—15th.

Edward N. Smith, West Brookfield, Massachusetts, in the United States of North America,—"A machine to fold paper."—17th.

Edward John Dent, Strand, Middlesex, chronometer-maker,—"Improvements in compasses for navigation, surveying, and similar purposes."—17th.

William Herbert Gossage, Stoke Prior, Worcester, chemist,—"Improvements in obtaining certain metals from some compounds containing such metals, and in obtaining other products by the use of certain compounds containing metals."—17th.

Jean Jules Varillat, Rouen, France, manufacturing chemist,—"Improvements in the extraction and preparation of colouring, tanning, and saccharine matters from various vegetable substances, and in the apparatus to be employed therein."—17th.

John Melville, Upper Harley-street, Middlesex, Esq.,—"Certain improvements in the construction of railways and locomotive engines and carriages."—17th.

Henrietta Brown, Long-lane, Bermondsey, widow and executrix of the late Samuel Brown,—"Improvements in the manufacture of metallic casks and vessels."—(Communication.)—17th.

John Silvester, Westhromwich, Stafford, whitesmith,—"Improvements in straightening, flattening, setting, and shaping hardened steel."—17th.

Ezekiel Edmonds the younger, Bradford, Wiltshire, cloth manufacturer,—"Improvements in the manufacture of certain descriptions of woollen fabrics."—17th.

SCOTCH PATENTS.

Sealed from 24th June, 1850, to 22d July, 1850.

William Wood, Over Darwen, Lancashire, carpet manufacturer,—"Improvements in the manufacture of carpets and other fabrics."—24th June.

Moses Poole, Patent Office, gentleman,—"Improvements in machinery for punching metals, and in the construction of springs for carriages, and other uses."—28th.

Peter Armand le Comte de Fontainemoreau, 4 South-street, Finsbury, Middlesex, patent agent,—"Certain improvements in the manufacture of sulphate of soda, muriatic, and nitric acids."—(Communication.)—July 3d.

Thomas Dickson Rotch, Drumlamford-house, Ayr, Esq.—"An improved mode of manufacturing soap."—3d.

William Cormack, 60 King-street, Danston-road, Haggerstone, Middlesex, chemist,—"Certain improvements in purifying gas, also applicable in obtaining or separating certain products or materials from gas, water, and other similar fluids."—10th.

Robert Andrew Macfie, Liverpool, Lancaster, sugar refiner,—"Improvements in manufacturing, refining, and preparing sugar, also improvements in manufacturing and treating animal charcoal."—10th.

Richard Roberts, Manchester, Lancaster, engineer,—"Improvements in the manufacture of certain textile fabrics, in machinery for weaving plain, figured, and terry or looped fabrics, and in machinery or apparatus for cutting velvets and other fabrics."—12th.

John Stevenson, Roan Mills, Dungannon, Tyrone, flax spinner,—"Certain improvements in machinery for spinning flax and other substances."—17th.

James Thompson, Glasgow, Lanark, civil engineer,—"Improvements in Hydraulic machinery, and in steam-engines."—17th.

Tempest Booth, Ardwick, Lancaster, gun manufacturer,—"Certain improvements in the method of, and apparatus for, obtaining and applying motive power."—19th.

Peter William Barlow, Blackheath, Kent, civil engineer, and William Henry Barlow, Derby, civil engineer,—"Improvements in the permanent ways of railways."—22d.

IRISH PATENTS.

Sealed from 24th June, 1850, to 17th July, 1850.

Thomas Dickson Rotch, Drumlamford-house, Ayr, Esq.,—"Improvements in separating various matters usually found in certain saccharine, saline, and liqueous substances."—(Communication.)—24th June.

James Hard Hoby, Blackheath, Kent, Esq.,—"Certain improvements of parts of the permanent way of railways, and in shaping iron."—15th July.

Francis Tongue Rufford, Prescott House, Worcester, fire-brick manufacturer; Isaac Marson, Cradley, in the same county, potter; and John Finch, Pickard-street, City-road, Middlesex, manufacturer,—"Improvements in the manufacture of baths and wash tubs or wash vessels."—17th.

George Jackson, Belfast, Ireland, flax-spinner,—"Improvements in hackling machinery."—17th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 21st June, to 16th July, 1850.

June 21st,	No. 2344.	Joseph Lester, 1 Great Cambridge-street, Hackney-road,—"Filtering funnel."
—	2345.	Henry B. Hewett, 308 High Holborn, and 45 Ludgate-hill,—"Chaud froid."
22d,	2346.	Samuel and Frederick Hattersley, Westbrook Works, Bradford,—"Shaping-plate for forming the cop or spool in spinning yarns."
24th,	2347.	John Goulding, John George Goulding, and Alfred Goulding, 1 and 2 Eden-street, Finsbury, office furniture makers,—"Omnium office table."
25th,	2348.	Abraham Auguste Neuburger, 4 South-street, Finsbury,—"Improved night-lamp boiler."
—	2349.	Thomas Dowler, Birmingham,—"Match-box."
26th,	2350.	Thomas Ryan Pinches, Oxendon-street, Haymarket,—"Purse envelope."
—	2351.	Leonard Hicks, Leeds,—"Cape coat."
—	2352.	John Sellers, Sheffield,—"Razor."
—	2353.	Stephen Sharp, Stamford,—"Lump-sugar cutting machine."
—	2354.	Webb & Greenway, Birmingham,—"Cupboard-fastener."
27th,	2355.	James and George Johnstou, Paisley,—"Cutting apparatus for bonnet tops."
28th,	2356.	Hopwood & Armstrong, St. George's-street, Wellclose-square,—"A door and apparatus for closing the opening of ship's scuttles."
29th,	2357.	Anthony Ettrick, Highbarne, Sunderland,—"Travelling-bag or portmanteau."
July 1st,	2358.	Charles Cowper, Southampton-buildings, Chancery-lane,—"An addition to a braiding machine."
—	2359.	Henry Alfred Jowett, Sawley, Derby,—"Parts of a signal-lamp."
2d,	2360.	James Woods, Stowmarket, Suffolk,—"Bruising and grinding-mill."
3d,	2361.	George Simpson, Spurrier-gate, York,—"The York coat or paletot."
4th,	2362.	William Walker, Manchester,—"Ventilating chimney tube."
—	2363.	John Ashford, Birmingham,—"Umbrella rail and water-box for church and chapel pew, carriage, and other doors."
5th,	2364.	Joseph Foxall & Co., Thaivies' Inn,—"The triumfante pen."
—	2365.	Charles Wilford, Brompton,—"Rotary steam-engine."
6th,	2366.	William Collins, Jun., Glasgow,—"Security envelope."
—	2367.	Thomas Purdon, Hull, "Portable bureau."
9th,	2368.	Thos. Yates, Birmingham,—"Preserve-pot for mustard, pickles, and other articles."
—	2369.	Anna Maria Breton, Lower Berkeley-street,—"Embroidering frame."
10th,	2370.	James Carter, Lamb's-buildings, Bunhill-row, and Johnson Wood, 103 Leadenhall-street, City,—"Nautical state-cabin basin."
12th,	2371.	William Garnett, Tarporley, Cheshire,—"Spring for a saddle."
—	2372.	William Crosskill, Beverley Works, near Hull,—"Feeding apparatus for threshing machines."
—	2373.	Deane, Dray, & Deane, King William-street,—"Steam boiler."
13th,	2374.	William Raynard Lane, Strand,—"Economic percolator."
—	2375.	William Thomas Loy, King-street, Westminster,—"Tudor razor guard."
—	2376.	Richard Robinson, Belfast,—"High combustion furnace."
15th,	2377.	R. Gray & Sons, Uddingstone, Glasgow,—"Draw-spring lever."
16th,	2378.	Richard Howson and Henry Howson, Manchester,—"Differential screwing apparatus for presses."
—	2379.	Thomas Key, Charing-cross,—"Regimental cased serpentcliede."

TO READERS AND CORRESPONDENTS.

G. R., Lincolnshire.—There is no existing work which furnishes such a detail. If the proprietors themselves would supply the particulars, something of the sort might be accomplished; but even a "short description" would require far more room than could be spared for such a purpose. Still, all hints are acceptable.

A Subscribea, Cork.—The Hand-Book of Turning—Ibbetson on Turning. Mr. Holtzapffel's posthumous volumes will probably be the best for him. When they will appear is uncertain.

R. M., Cheshire.—We shall be glad to receive the communication he mentions at his convenience.

J. R. C.—The modification he mentions is a very obvious one, and has been introduced in most modern works. We do not see why timber should not stand very well, although it must always make a clumsier appearance than wrought-iron. A thinking man will find many crude unmechanical contrivances in forge apparatus, as in many other works. If he produces anything worth showing, we shall be glad to give it a place. By all means try, it is excellent practice. The sketch sent is clear enough.

Oxygen.—It has been pointed out to us that Priestly was not educated as a Unitarian clergyman, but as a Calvanistic one. He adopted the Unitarian doctrines by preference.

J. H., Munich.—We are greatly obliged to our old correspondent for his communication of the 7th ult. We are preparing the drawings for publication.

Engineer, R.N.—The "Notes" are in preparation. They are very acceptable.

G. C.—He will see our remarks of this month. If he will favour us with a note as to the bearing of both of the schemes mentioned upon his own, we will make use of it next month.

Mr. Lester, London.—In the September Number. We are obliged by his attentions.

Neilson's Steam Crane.—For reasons over which we have no control, we have been obliged to substitute "Brodie's Tile Machine" for this plate this month.

Artificial Light.—In the article on this subject, page 86, last month, the three lines beginning—"It works freely," refer to the probe for trimming. They are misplaced. At fifteenth line from bottom, for "cap" read "cup."

THE BRITISH ASSOCIATION IN EDINBURGH.

The classic walls of Edinburgh have this year encircled this august body; and it is a pleasant duty to record the fact, that this, the twentieth annual meeting, under the presidency of its earliest promoter, Sir David Brewster, has been in the highest degree successful. Apart from the more immediately interesting business of the meeting, the congregating visitors have been no less delighted with the hospitality of the denizens of "Auld Reekie," than with the palatial grandeur of the streets and romantic neighbourhood of the "Modern Athens."

From the share which the metropolis of the north has had in originating and fostering this now giant Association, it may easily be conceived that its members would be welcomed again, on their second visit, with the cordiality which hallows the meeting of old friends. The older members looked forward to a reunion with the familiar faces of bygone meetings, and even the younger ones had their kindly remembrances, although their recollections perhaps dated no further back than Birmingham, September, 1849. The charming weather contributed not a little to the brilliant muster, and at the general meeting, held on the evening of Wednesday, the first and merely formal day of the gathering, Professor Phillips, the Assistant General Secretary, was able to announce that the names of 894 members had been enrolled. The list gradually swelled out, until near the conclusion of the "scientific holiday," when upwards of 1,200 names were "borne on the hooks." The meeting was formally opened by the General Committee, at one o'clock, on Wednesday the 31st of July; Dr. Robinson, president of the previous year, in the chair. After the minutes of the two last committee meetings at Birmingham were read, Sir R. Murchison moved, and Sir Charles Malcolm seconded, the addition of the distinguished name of Professor Jameson to the list of vice-presidents of the year, the eminent professor, which, by an unfortunate oversight, had been omitted at the Birmingham meeting. The energetic general secretary, Colonel Sabine, being absent, as we were sorry to learn, from ill health, his colleague, Dr. Royle, read the report of the Council, embodying several important statements of the labours of the Association. Afterwards, Mr. John Taylor, the worthy treasurer, read the accounts of the past year, showing a balance, at the opening of the Edinburgh meeting, of £404 in favour of the Association funds.

In the evening, the first general meeting was held in the Music Hall, the chair being filled by the retiring president, Dr. Robinson, who, in abdicating his chair, inducted Sir D. Brewster with the following remarks, which are at once eloquent and touching:—

"The time has come, when, by our rules, I must lay down the authority which, last year, you honoured me with. I trust that, from the way in which I have employed it, I have not altogether proved myself unworthy of the confidence which you then reposed in me. I have at least this to boast of—which it is not every sovereign who can congratulate himself upon at the close of his career—that I shall deliver to my successor my dominion in a more prosperous and in a more flourishing state than I received it. But more: I have this additional consolation, in entering again among your ranks, that at least I shall not be visited by the affliction which pressed so heavily upon the mind of Solomon, that when he had laboured in the pursuit of wisdom and in the advancement of knowledge, he should leave his portion to one who had not laboured therein; for I deliver my authority to one, in comparison of whose achievements, whatever I myself may, by the partiality of my friends, be supposed to have effected, fades into nothing. There is not a spot in the world to which the light of physical investigation has pierced, where his name has not become, as it were, a household word. There has been no period in the course of this Association, prosperous and successful as it has been from its origin, in which we have not been enlightened by his discoveries and aided by his counsel. There is not a department in that multifarious lore with which we have employed ourselves, on which he has not, in the course of his investigations, thrown a brilliant light; and what I prize beyond all that he has achieved—as the distinction or the fame of the whole of that career which has been so brilliant—is, that there has not been any stain or any cloud to obscure the moral purity, the religious veneration, the upright and conscientious spirit, which, more than all knowledge, and more than all genius, is the noblest prerogative of man. When I resign my throne of office to Sir David Brewster, I know that that act is perhaps the greatest service which, in the course of my connection with the Association, I have ever rendered to it."

On the admirable address given by the president-elect on taking his seat, we need not comment here, as we give it elsewhere *in extenso*.

The first day of August ushered in the real business of the meeting, and the several sections set to work in good earnest, in the rooms assigned to them in the College. Being within what we may term a "ring fence," the well-appointed class-rooms of the University afforded admirable accommodation both for the professors and their scientific listeners, without entailing the inconvenient loss of time always arising from a scattered distribution of quarters. Section G, Mechanics, under the presidency of the ex-president-in-chief, Dr. Robinson, was opened by an interesting paper by Mr. Scott Russell, being "A report from Rio Janeiro on the progress of the Wave principle, as applied to the construction of ships in the Brazils." This paper gave details of the progress made in carrying out the wave principle in the Brazils, during the last six years. In the subsequent discussion upon the principle as adopted in sailing-yacht schooners in England, it was shown that the Titania, which is an example of this system of construction, had proved herself the fastest craft of her size. Mr. Stokes followed with a paper by Mr. Homersham Cox, "On the Hyperbolic Law of the Elasticity of Cast-iron." Mr. Ruthven then exhibited a model boat, showing the application of his modified arrangement for propelling vessels by the reactive pressure of a jet of water. Our pages have already taken note of the contrivance. It did not find much favour in the eyes of the president, who gave Mr. Ruthven some wholesome advice upon the necessity of submitting his proposed plan to the critical examination of some investigator versed in the mathematics of hydraulics. Mr. Macpherson afterwards read an interesting paper, "On a method of preventing Water-Pipes from bursting with frost." The author gave some statistical details of the alarming extent of the damage to property caused by the frequent bursting of pipes, and expressed his opinion that the only really practical way of getting rid of the evil is, to shut off the water from the service-pipes during frost, after the requisite supply has been drawn. After a very extensive series of experiments, he has arranged an automatic system of shutting-off, by ingeniously taking advantage of the expansive power of freezing water. A piston, contained in an open-topped cylinder, is elevated by the expansive pressure of the ice in process of formation beneath it, and the movement thus obtained closes the water supply-pipe. Mr. John Taylor spoke very feelingly on the subject of the disagreeables attending the bursting of pipes, as he had himself been a victim to them. He had some time since attempted to overcome the difficulty by shutting off the water by hand, but, unfortunately, it invariably happened that the frost was beforehand with his servants, and the stop-cock was closed a day too late. Mr. Macpherson's plan would make him independent of extraneous assistance, as the frost must, with such a contrivance, take the care and trouble of letting out the water off his hands. Mr. Nasmyth's "Practical Notes," on forging and welding iron, concluded the day's transactions. The system of swaging and welding on a V grooved anvil, which formed the prominent feature of the author's remarks, will be found to be figured and described at page 223 of our first volume. The evils of welding and hammering between flat or parallel surfaces, refer more especially to the unsoundness of large shafts and similar forgings, as the tendency of this treatment is to disintegrate the mass of metal from the centre outwards, producing a fibrous crumbling effect. In the recent experiments on the strength of chain-cables, undertaken for the Admiralty, it was found that the fractures arising from defective welding, as compared with those occurring through the pure substance of the metal, were as eight to one. As a remedy, he proposes

that the welding surfaces should not be flat, but convex; so that the welding action, commencing at the centre or apex of the convexity of the bars, should gradually work outwards, forcing out the scale or cinder which forms on the surfaces of the metal, and allowing of pure metallic contact between the welding surfaces. By the aid of comparative sketches, the author showed that, in the old plan of welding up a mass of bars, each layer retained the surface scale, invariably producing a defective weld; whilst, in the new one, the very act of welding squeezed out the foreign matters, allowing the separate portions of metal to incorporate freely into a homogeneous mass.

On Friday the 2d ult., Mr. Nasmyth described "A new arrangement of the Reflecting Telescope, by which great additional comfort and convenience are afforded to the observer;" and this was followed by several communications from Professor P. Smith of the Edinburgh Observatory, on various improvements in astronomical apparatus, and "On a mode of cooling the air of Rooms in tropical climates." He exhibited sketches of an ingenious design for a "Portable Folding Dome for extra-meridian instruments." The dome is of wood, with an octagonal top, each division of which is capable of opening or folding down, for the convenience of taking observations in any quarter. This contrivance has been found very serviceable in India—the one noticed by Professor Smith having been in use for several years in localities very far asunder. The "mode of cooling air" is also a result of Indian practice. It is a very elegant application of the well-known fact of the excessive evolution of heat by air under pressure. Advantage is taken of this by compressing the air into a receiver, by a force-pump placed outside the house to be cooled. The compressed air—taken, say at 90°, from the external atmosphere—is passed through a spiral tube in a vessel of water, and the evolved heat is thus carried off until the water and air arrive at the same point of temperature. We have thus air in a high state of compression, with its heat, as it were, squeezed out of it. It is then passed through a second spiral tube, passed through a cooling vessel, and is allowed to expand into the apartment to be cooled. The supply thus carried into the house is then, in its expanded state, as much cooler than the natural temperature of the atmosphere at the time being, as it was hotter, in its compressed state, previous to the radiation of its heat. As graphically shown by the president, this cooling process may be illustrated by a sponge filled with water. The sponge represents the air, the water its contained caloric, which, by compression, is squeezed out—the empty sponge representing the cooled air.

This paper furnishes a pointed illustration of the important effects frequently produced by the scattering of ideas, immaterial in themselves, but capable of the most valuable practical application in the hands of a scientific observer; for Mr. Taylor at once stated his conviction, that the scheme might be applied for a purpose in which he is eminently interested—the lowering of the temperature in mines. In a mine now working under his superintendence—although only 200 fathoms have been reached—the men are labouring in an atmosphere heated to about 110°. This great heat, of course, arises from some local cause, so far unascertained, for it is quite at variance with the generally observed ratio of the increase of temperature according to the depth.

Mr. Appold, a steady labourer in the ranks of the Association, then exhibited and described his ingenious "Register Hygrometer, for regulating the atmospheric moisture of houses," as described by us in another page; and the proceedings of the day terminated with a description of "An improved Gas Stove," by Mr. Sykes Ward of Leeds.

Saturday, the established excursion-day, opened in the most favourable manner. Two routes were laid down in the programme. One to the Bass Rock and Tantallon Castle, taking in North Berwick Abbey, Dirleton Castle, and Gulane Church. The other was to the Pentland Hills and the Water Company's Works. A special invitation was also issued to a goodly number, by the Commissioners of Northern Lights, to visit the Bell-rock Lighthouse and the Isle of May, per steamer.

The Pentland Hill scheme fell through from some failure in the arrangements, and a large number of the excursionists contented themselves with a geological visit to Arthur's Seat.

We made choice of the Bass as our "sight" for the day, and started at 9 a.m., with a party of some 300, per North British Railway, for North Berwick. On reaching the pier, some confusion occurred from a want of sufficient boat accommodation, but we at last succeeded in stowing ourselves on board a neat little yacht, most handsomely placed at our disposal by the owner, Vice-Admiral Sir Charles Malcolm, with Mr. Girle of North Berwick as captain. Although heavily laden—so much so as to compel the ladies of the party to take possession of the cabin—the fine breeze carried us rapidly over the two-and-a-half miles of sea, and brought us to the little angular creek on the south side of the Bass Rock, where only a single boat can approach to the steep and slippery landing. The difficulties both of ascent and descent, owing to the dry slipperiness of the ground, will be long remembered by the adventurous visitors who climbed it. Rising to a height of 400 feet sheer out of the sea, this extraordinary rock presents many features of the greatest interest—its precipitous and rugged sides, cleft here and there with yawning ravines—the ruined prison of the Covenanters—the innumerable solan geese, nestling on the bare rock—and lastly, the weather-beaten cairn on the summit, with the magnificent stretch of prospect on every side, across the Frith of Forth, and out to the North Sea, combine to render it the most remarkable of the numerous rocky islets on the coast. Whether we view it geologically, as a volcanic mass; historically, as "a feudal stronghold, a pirate's concealment, a government prison, a rebel fastness, or a martyr's dungeon;" or picturesquely, for its wonderful height and irregularity of feature, it equally deserves the admiration which its explorers bestowed upon it.* After regaling on sandwiches, which some thoughtful member had provided, our fleet again set sail shoreward for Tantallon Castle, the ancient stronghold of the Douglases.

"Tantallon vast,
Broad, massive, high, and stretching far,
And held impregnable in war.
On a projecting rock it rose,
And round three sides the ocean flows,
The fourth did battled walls enclose,
And double mound and fosse;
By narrow drawbridge, outworks strong,
Through studded gates, an entrance long,
To the main court they cross.
It was a wide and stately square,
Around were lodgings fit and fair,
And towers of various form,
Which on the court projected far,
And broke its lines quadrangular;
Here was square keep, there turret high,
Or pinnacle that sought the sky,
Whence oft the warder could descry
The gathering ocean-storm."

With the Bass Rock fronting them in the distance, what a magnificent prospect the residents of the castle must have enjoyed! After the description of the author of "Marmion," our readers need no further account.

On leaving the castle, the visitors wended their way along the shore to North Berwick again, where our captain of the morning, G. H. Girle, Esq., threw open his doors, and gave us a hearty welcome, and—a capital luncheon. To say how much we were indebted to him for his timely relief, would be faint praise. Far more than all our thanks, and more than all compliments, he will feel that he will "live in the remembrances" of the members of the British Association.

Mr. Palmer Budd opened the Mechanical Section on Monday, with a statement of some further results of the "Value of Gascous-escape from

* A facetious visitor has recorded his experiences of this visit in a short paper, which will be found in our "Monthly Notes."

the blast-furnaces at the Ystalyfera Iron-works." This was a sequel to the excellent paper by the same author, read at the Swansea meeting. In Scottish iron-making, he calculates the economy likely to result from the adoption of his arrangements for turning the escape-gases to use, at £132,500 per annum, or about 4s. 5d. per ton upon the produce of the country.

Mr. Lassell of Liverpool, the well-known improver of the telescope, then gave an account of his new "Method of supporting a large Speculum free from sensible flexure, in all positions." His plan is to support the speculum at eighteen different points, the weight bearing equally on each; and by casting it with ribs, he proposes to adapt levers, so that when the telescope is elevated, they may bear the weight among them, without disturbing the true form of the surface. Mr. Scott Russell gave an account of a "New duplex Turning-lathe," by Mr. Whitworth. This lathe not only doubles the production of work, but does it in a much better style than is accomplished in the common lathe. Two cutters are used at once—one on each side of the work to be turned—so that, whilst two cutting actions are going on simultaneously, the pressure from each side removes the tremor arising from the side strain of a single tool. Mr. Beattie's pneumatic door-springs are already well known.

After Mr. Beattie's paper, Mr. Thomas Stevenson described his self-registering instrument for ascertaining the force of impact of waves per square foot; and Mr. Swan followed with some remarks "On the limits of the velocity of revolving Lighthouse apparatus, caused by the time required for the production of luminous impressions on the eye." The brightness of the impression he found to be in proportion to the time of making it. When the time is one-fiftieth of a second, for instance, the brightness was about one-tenth of the full light.

On Tuesday, the concluding sectional business day, Mr. G. Buchanan described, and practically experimented upon, his improved cocks and valves; and Professor Donaldson afterwards exhibited an extraordinary apparatus, contrived by the Baron de la Tour, for producing musical sounds under water. The Astronomer-Royal then made some statements relative to the construction of the pivots of the new transit circle for the Royal Observatory, Greenwich. After trying various plans for overcoming the defects of the ordinary pivots, the author, at the suggestion of Messrs. Ransomes and May, tried cast-iron, chilled, and the result has been so good, that he now states the action to be superior to anything else of the kind.

Sir D. Brewster communicated a note from M. Jules Guyot, on his priority of invention of the tubular bridge. The various opinions given on this sore subject are detailed in another page.

Another paper by the president, on an ingenious plan of tubular crane, invented by Mr. Fairbairn, was followed by a description of the Ashcstill bridge, by Mr. Smith; and the routine of proceedings terminated with a series of papers "On Electricity," and "On the powers of Minute Vision," by Mr. Petrie, and "On a telescopic sight for Rifles," by Professor Smith. Two subjects were afterwards added to the list—Mr. Usher's steam-plough, which he afterwards showed in operation, and the ingenious self-acting carriage-step, by Mr. Davies of London.

The general routine of the transactions was varied by a discourse from Dr. Bennett, "On the Motion of the Blood," and one by Dr. Mantell, "On the Extinct Birds of New Zealand." The eloquent remarks with which the latter paper was concluded, and the feeling terms in which the lecturer was addressed by Dr. Robinson, made a deep impression upon the listeners who crowded the Music Hall—would that our space permitted us to take some note of them. The usual promenades in the Music Hall filled up the remaining time. The last was a most brilliant affair, the rooms being completely filled with the members and the fashionable fair of Edinburgh. In the course of the evening, Mr. Nasmyth delivered a lecture on the structure of the moon, illustrated by a series of admirably-executed drawings, the work of his own hands. The details of the more interesting of these papers—of which we here give a mere catalogue—together with many others in the mathematical and physical, geological and chemical sections, will be furnished in our usual illustrative reports.

In reviewing the week's productions of the British Association, we are powerfully impressed with the amazing superiority of the system of combined action which its working presents. Taking in the whole range of scientific research, it apportions out to each of its labourers the work for which he is best fitted—and here the principle of the division of labour is as fully developed for the furtherance of the efforts of science, as it is in the homely and often-cited example of the manufacture of a pin.

The honour of welcoming the meeting of 1851 is assigned to Ipswich, where, under the presidency of the Astronomer-Royal, we look forward to another display of the scientific gleanings of the year.

THE PHILOSOPHY OF MATHEMATICAL SCIENCE.*

No. I.

Although mathematical science is the most ancient and most perfect of all sciences, the general idea to be formed of it has never yet been clearly determined. The definition of the science, and its chief divisions, still remain vague and uncertain. The plural name we commonly attach to it, would of itself suffice to indicate that want of unity usually conceived to belong to its philosophic character. In truth, it was only at the commencement of the last century, that the different fundamental conceptions constituting this great science, were sufficiently developed for the clear perception of the spirit of the whole. Since that period, the attention of geometers has been too much directed to the development of individual branches, and to their application to the more important laws of the universe, to allow of their duly attending to the general system of the science. But, at the present time, the progress of particular branches is no longer so rapid as to preclude a consideration of the whole. Mathematics are now sufficiently developed, both in themselves, and with reference to their most essential applications, and have arrived at that state of consistence which demands that the separate divisions shall be co-ordinated into a single system, as a preparation for new advances. Indeed, it may be observed that the last great additions to the science, have directly prepared this important philosophic operation, by impressing upon its principal parts a character of unity which did not previously exist.

With the view of presenting an accurate notion of the object of mathematical science, considered as a whole, we may begin with the usual vague definition, that it is the science of magnitudes; or, that it is the science which has for its object the measurement of magnitudes. Although this definition is much in want of depth and precision, the idea is just at the bottom; it is even sufficiently extensive when looked at from a proper point of view. In such a matter, moreover, it is important to build upon notions generally admitted. Let us see then, how, in starting from this rough sketch, we can expand it into a true definition of mathematics—a definition which shall correspond with the importance, the extent, and the difficulty of the science.

The notion of *measuring* a magnitude, does not of itself imply anything beyond a simple and direct comparison of that magnitude with some other known magnitude, which is taken for unity with respect to all magnitudes of the same kind. And therefore, when we limit ourselves in defining mathematics, to saying that their object is to measure magnitudes, the idea in view is very imperfect; for it is impossible to see what occasion there can be for any science, when that is the object, especially a science so vast and profound as mathematics is with justice reputed. In place of an immense concatenation of prolonged mental operations, which offer inexhaustible nourishment to our minds, the science, after such a statement, would appear to consist only of a simple series of mechanical processes, instituted with the view of obtaining directly, by operations analogous to the superposition of lines, the ratios of the quantities to be measured, with those by which we measure. Nevertheless, this definition has only the defect of not going sufficiently deep. It contains nothing erroneous as to the ultimate aim of the science; but it represents as direct an object, which, on the contrary, is almost always indirect, and hence it gives no true conception of the nature of the science.

To obtain such a conception, it is first necessary to consider a general fact, very easy to prove. It is this, that in far the greatest number of

* A Chapter in Auguste Comte's Cours de Philosophie Positive.

instances, the direct measurement of a magnitude by superposition, or by any similar process, is a matter of impossibility; so that, if we had no other means of determining magnitudes than this, we should be obliged to abandon the attempt of ascertaining most of those which we desire to know The force of this observation will be understood, if we consider the particular case which will probably first fall under our notice—that of the measurement of a right line by another right line. This comparison, which is the simplest that we can imagine, can very seldom be immediately effected. In considering what would be required, in order to be able to make a direct comparison of one line with another, we shall see that, in most cases, all the conditions cannot on any one occasion be fulfilled. The first and most palpable of such conditions, that of being able to pass from one end of the line to be measured to the other, in order to compare every part of its length, is evidently impossible in by far the greatest number of those distances which interest us. I need only refer to the distances between the different heavenly bodies, or to the distance between the earth and some of the heavenly bodies; nay, even to very many terrestrial distances, distances which are so frequently inaccessible. When this difficulty has been got over, it is still necessary that the length be neither too great nor too little, for this would render the direct measurement equally impossible. Then it must be conveniently situated, and so forth. In fact, a very slight circumstance, which beforehand would not seem to throw any difficulty in the way, will often suffice to prevent any direct measurement. Thus, for instance, a line which, if it were placed horizontally, could be easily measured, cannot he so if it is in a vertical position.

But if there are insurmountable difficulties with respect to the direct measurement of many *lines*, the difficulties are still more numerous as respects the measurement of surfaces, volumes, velocities, &c. Now, it is this general fact which renders mathematical science necessary. Being compelled to forego, in most cases, the direct measurement of magnitudes, we are obliged to seek such magnitudes indirectly, and hence the origin of mathematics.

The general method which is constantly employed, the only one evidently that we can conceive, to ascertain magnitudes which do not allow of direct measurement, consists in connecting them with others which may be at once determined, and by means whereof we come to discover the first, by means of the relations between the two. Such is the object of mathematical science surveyed as a whole. In order to form a notion of it sufficiently extensive, we must consider that this indirect determination of magnitudes, may have very different degrees of indirectness. In a great number of cases, which are often the most important ones, the magnitudes, by means whereof we seek to determine others, are themselves incapable of being directly ascertained; and must, consequently, in their turn, become the subject of an inquiry similar to that already described. And this inquiry may have to be carried another step back, and so on; so that, in many instances, the mind is obliged to contrive a long series of intermediate steps between the system of unknown magnitudes which form the real object of inquiry, and the system of magnitudes which are capable of direct measurement; the latter seeming at first, perhaps, to have no connection whatever with the former.

This general explanation may be illustrated by a few examples. Let us consider, in the first place, a very simple natural phenomenon, which may, nevertheless, give rise to a mathematical question susceptible of effective applications, the phenomenon of the vertical fall of heavy bodies.

In noticing this phenomenon, even the person who is least conversant with mathematical conceptions, immediately perceives that the two elements it presents (namely, the height whence a body has fallen, and the time elapsed during the descent), are necessarily connected with each other, because they simultaneously vary or remain the same, or, in the language of geometers, they are *functions* of each other. The phenomenon, therefore, under this point of view, gives rise to a mathematical question, to get at the dimensions of one of these magnitudes which cannot be directly ascertained, by means of the other which can be so ascertained. It is thus that we are able to learn the depth of a precipice, when the only information we possess is the length of time that a heavy body takes to fall from the top to the bottom; and by a proper course of procedure, we shall obtain the dimensions of an inaccessible spot, as accurately as if we had measured it in a horizontal position, under the most favourable circumstances. In other cases it is easy to learn the height from which a body has fallen, whilst the time of the descent cannot be directly ascertained, and then the same phenomenon will give rise to the inverse question to determine the time by the height; as if, for example, we wished to know how long a body would be in falling from the moon to the earth.

In this instance, the mathematical question is a very simple one, at least when the variations in the intensity of gravity, and the resistance of the fluid medium traversed by the body in its descent, are disregarded. But the difficulties of the question will be much increased, if we consider the same phenomenon in its most general aspect, in supposing the path of descent to be oblique, and taking into account the principal attendant circumstances. Then, instead of simply offering us two variable elements, mutually connected by a relation easily traced, the phenomenon will embrace a great many elements, the space traversed, whether vertically or horizontally, the time occupied, the velocity of the body at each point of its course, and even the intensity and direction of the original impulse, which can also be considered as variable; and finally, the resistance, in certain cases, of the medium and the force of gravity. All these different elements will be mutually connected in such a manner, that each in its turn can be determined indirectly by the others, and this will offer us many distinct mathematical questions, as there are coexistent magnitudes in the phenomenon. Thus, a very simple alteration in the physical condition of a problem, will at once place a mathematical inquiry, originally quite elementary, amongst those very difficult questions, the complete and rigorous solution of which is at present beyond the powers of the human mind.

Let us take another example from amongst geometrical phenomena. It is proposed to determine a distance not capable of direct measurement: it will generally be conceived as forming part of a *figure*, or of some system of lines chosen in such a manner that all its other elements can be immediately observed. For example, in the simplest of cases, and that to which all others can in the end be reduced, we will consider the required distance to belong to a triangle, in which we can directly determine either one side and two angles, or two sides and one angle. With these data, the required distance, instead of being directly obtained, will be the result of a mathematical calculation, whereby it will be deduced from the observed elements, according to the relation connecting them. This calculation will become more and more complicated, if the given elements cannot, as frequently happens, be determined, except in an indirect manner, by means of new auxiliary systems, the number of which, in large operations of this nature, is sometimes very considerable. The distance, when once determined, will frequently lead to a knowledge of new quantities, affording materials for fresh mathematical questions. Thus, when the distance at which an object is placed is known, the simple observation of its apparent diameter will enable us to determine indirectly its real dimensions, however inaccessible it may be, and, by a series of analogous researches, its surface, volume, even its weight, and a number of other properties, from a knowledge of which we seemed to be cut off.

By such calculations as these, man has come to know, not only the distances of the stars from the earth, and their distances from each other, but their magnitudes, figures, even to the inequalities of their surface; and what seems still more to be concealed from us, their masses, their mean densities, the chief circumstances of the descent of heavy bodies at their surfaces, &c. By the help of mathematical theories, the discovery of all these different facts, and many others connected with the different classes of natural phenomena, requires the actual measurement of only a very small number of right lines, properly chosen, and of a greater number of angles. Nay, in order to show the capabilities of the science, we might declare, in all strictness, that if we did not shrink from the multiplication of mathematical operations, but had recourse to them, even where direct measurement is possible, a knowledge of all the magnitudes capable of precise estimation, which the different orders of phenomena offer, would in the end be acquired, from the direct measurement of a single right line, and a number of angles.

We are now in a situation to give an exact definition of mathematical science, in assigning for its object the *indirect* measurement of magnitudes, and in saying that we invariably propose *to determine magnitudes by one another, according to the precise relations which exist amongst them.* This exposition, instead of referring to an *art*, like all the ordinary definitions, at once characterises a true *science*, and immediately exhibits it as composed of an immense concatenation of intellectual operations, which, it is evident, may become very complicated by reason of the series of intermediate links, which must be established between the unknown quantities, and those which admit of direct measurement, by reason also of the coexistent variables in the question proposed, and the nature of the relations which the phenomena will supply, between all these different magnitudes. According to such a definition, the mathematical spirit consists in always regarding as interdependent, all the quantities which any given phenomenon can present, with the view of deducing some from others. And since there is no phenomenon which cannot give occasion to considerations of this kind, the indefinite extent, and even the rigorous logical universality of mathematical science are evident. Hereafter we shall endeavour to limit as exactly as possible its real extent.

The foregoing explanations clearly justify the name employed to

designate the science under consideration. This name, which at the present time has taken so determinate an acceptation, simply signifies, by itself, *science* in general. Such a designation, rigorously exact for the Greeks, who had no other *science*, could only be retained by the moderns, as indicating the *science* par excellence. And, in fact, the definition to which we have been led, if we put out of view the circumstance of the precision of the determinations, is nothing but the definition of all true science whatsoever; for has science any other object than to determine some phenomena by means of others, according to the relations existing amongst them? All *science* consists in the co-ordination of facts; if the different phenomena were totally isolated, there would be no science. We may even say broadly, that science is essentially destined to dispense, as far as the different phenomena will permit, with all direct observation, by allowing us to deduce from the smallest possible number of immediate data, the greatest possible number of facts. Is it not here where lies the real use, both in theory and practice, of the laws which we discover in natural phenomena? Mathematical science, according to this, does no more than push to the highest possible degree, both in relation to quantity and quality, and with respect to matters really within its scope, the same kind of inquiries which other sciences institute in their respective provinces, but in a more or less inferior manner.

It is, therefore, only by the study of mathematics that we can obtain a just and profound idea of *science* in general. It is only in it that we must search to know with precision the general method constantly pursued by the human mind in all its positive inquiries, because nowhere else are the questions resolved in so complete a manner, or the deductions pursued so far with rigorous severity. It is here, also, that the human mind has given the greatest proofs of its powers, because the ideas here considered are of the highest possible degree of abstraction in the positive order. All scientific education, therefore, which does not commence with such a study, has necessarily a defective foundation.

Hitherto we have surveyed mathematical science only in its entirety, having altogether disregarded its divisions. In order to complete this general view, and form a just idea of the philosophical character of the science, we must now consider its fundamental divisions.

These divisions will only be really rational, and derived from the very nature of the subject, in so far as they have been spontaneously presented to us in making an exact analysis of a complete mathematical question. Thus, after having determined, as above, the general objects of mathematical operations, we will now mark out the several principal kinds of inquiry into which such operations invariably fall.

The complete solution of every mathematical question is necessarily divided into two parts, essentially distinct in their nature, and invariably determinate in their relation. We have seen that all mathematical research aims at determining unknown magnitudes, by means of relations existing between them and certain known magnitudes. Now, it is evident, that to this end we must learn accurately the relations existing amongst the quantities which we have to consider. This first branch of inquiry constitutes what I call the *concrete* part of the solution. When that is terminated, the nature of the question is changed—it becomes reduced to a pure question of numbers, consisting simply in determining certain unknown numbers, from a knowledge of the precise relations connecting them with certain known numbers. This is the *abstract* part of the solution. Hence, mathematical science is divisible into two grand sciences, abstract mathematics and concrete mathematics. This analysis may be remarked in every complete mathematical question, however simple or complex it may be. A single example will be sufficient to render it intelligible.

Returning to the phenomenon of the vertical descent of a heavy body, and considering the simplest case of descent, it is seen, that for the determination of the height by the duration of the fall, or *vice versa*, we must begin by discovering the exact relation of these two elements, or, using the language of geometers, their *equation*. Before this first inquiry is terminated, every attempt to determine numerically the value of one of these magnitudes by that of the other, would be evidently premature, because there could be no ground to work upon. It is not enough to have a vague notion of their mutual dependence—everybody obtains that at first sight; but we must determine in what this interdependence consists. Such an inquiry may be very difficult, and, in fact, in the case before us, it constitutes incomparably the most difficult part of the problem. The true scientific spirit is so modern, that no one, perhaps, before Galileo, had even noticed the increase of velocity which a body receives in the progress of its fall. This fact, of course, excludes the hypothesis of the height being proportional to the time, an hypothesis which the mind, always ready to presume the simplest *functions* in every phenomenon, would be naturally led to form. In a word, this first inquiry was ended by the discovery of the law of Galileo. This concrete part of the question being resolved, the rest is altogether of another kind. Knowing that the spaces traversed by a body in each successive second of its descent increase as the series of the uneven numbers, we have before us the problem—purely numerical and abstract—of deducing either the height from the time, or the time from the height; and this will consist in finding, that, according to the established law, the first of these two quantities is a known multiple of the second power of the other, and hence we shall arrive at the value of the one when that of the other is given.

In this instance the concrete question is more difficult than the abstract question. The reverse would be the case if the same phenomenon were considered in its widest generality, such as I have previously contemplated on another account. It varies with the circumstances which of these parts shall present the greatest difficulty. Sometimes the mathematical law may be very simple, but difficult to find; at other times easy to discover, but very complicated; so that the two great sections of mathematical science, when compared with each other through many cases, may be regarded as equal in extent and difficulty, as well as in importance.

These two parts, essentially distinct with regard to the object proposed, as is shown by the preceding explanation, are not less so by the nature of the inquiries of which they are composed.

The first is properly named *concrete*, because it is evidently dependent upon, and will necessarily vary with, the character of the phenomena considered; whilst the second is entirely independent of the nature of the objects examined, and is only concerned with the numerical relations which they present, and hence it is properly termed *abstract*. The same relations may exist in a great number of different phenomena, and these, in spite of their extreme diversity, will be looked at by mathematicians as offering the same analytical question, capable, when studied by itself, of being resolved once for all. Thus, for instance, the same law which governs the relations of the space and the time in examining the fall of bodies in vacuum, is found in other phenomena offering no analogy to the first, nor to each other; for it expresses also the relation of the area of a spherical body to its diameter; it determines also the decrease of the intensity of light and heat, with the distance of the objects illuminated and heated, &c. The abstract part, common to all these different mathematical questions, having been treated with reference to any one of them, has been treated for all; whilst the concrete part must necessarily be separately studied in each, seeing that the previous solution of any one will afford no aid in solving the rest. It is impossible to lay down general methods, which, by a determinate and invariable process, insure in all cases the discovery of the relations existing between elements, relatively to any phenomena whatsoever. Special methods only can be employed for this or that class of phenomena, geometrical, mechanical, thermological, &c. On the contrary, from whatever source the elements themselves are derived, we can lay down general methods for deducing some from others, supposing their exact relations to be known. The abstract part of mathematics is therefore general in its nature; the concrete part, special.

In presenting this comparison under a new point of view, we can say that concrete mathematics have a philosophical character, essentially experimental, physical, phenomenal; whilst that of abstract mathematics is purely logical and intellectual. This is not the place for discussing the processes employed by the human mind in the discovery of the mathematical laws of phenomena. But whether exact observation suggests the law, or whether, as often happens, it only confirms the law constructed by our reasoning faculties from a consideration of the commonest facts, it is certain that this law is looked upon as real, only so far as it is shown to agree with experience. Thus the concrete part of every mathematical question is necessarily founded upon the consideration of the exterior world, and can never be resolved by any possible combination of intellectual operations. The abstract part, on the contrary, when it has been accurately separated, can only consist in a series of deductive reasonings of greater or less length. For if we have once discovered the equations of a phenomenon, the determination of some, by others of the elements, is within the jurisdiction of the reasoning faculties alone, whatever may be the difficulties they, in any respect, present. It is the office of the mental powers to deduce from these equations the results that are comprised in them, perhaps in a very complicated manner, without having occasion to consult anew the exterior world, the consideration of which, being henceforth foreign to the process, ought to be carefully excluded, in order to confine the operation within its own peculiar bounds.

From this general comparison, we see how natural and profound is that division of mathematical science above laid down.

WILSON'S IMPROVED STEAM MACHINERY.

(*Illustrated by Plate* 55.)

The first duty of the contriver of a machine, is to see that its action and effect are safe—that human life is not inordinately endangered by its adoption and use. The past history of the steam-engine affords but too many melancholy instances of the gross neglect of the precautionary measures necessary in the management of a power so useful and docile under proper restraint, and so fearfully destructive under circumstances the reverse, as steam. In late years we have heard less of fatal explosions; but their number is still sufficient to call for all the inventive talent of the engineer, in devising means for obtaining increased safety—otherwise the appalling nature of these accidents, when they do occur, will continue to foster the long-prevailing impression of the past half century, that railway and steamboat conveyance is fraught with danger.

The modern archives of this country do not furnish us with any accurate statistical information on the point; but if any evidence as to the general safety of steam conveyance were yet wanting, we might refer to what has been collated in America, whose explosions out-number ours tenfold. In the "Report of the Commissioner of Patents to the Senate of the United States on the subject of Steam-boiler Explosions," we find it stated that the whole number of steam vessels built in America, from 1830 to 1847 inclusive, was 1,915; and the losses by explosion, during this period, were 198, or about 10 per cent. The steamboat tonnage of the western rivers was, in 1846, 249,055; the probable extent of the steam navigation being 16,674 miles. In these casualties, the annual average loss of life is given at 110, and the number of wounded at 92—total, 202.

To give a fair comparison of these losses with those of other vessels, it would be necessary to take an equal number of each kind having the same route, and exposed to the same sources of danger; but there are many difficulties in the way of the obtainment of such a comparison, and we must be content with a general estimate. This may be made from a memorial addressed to Congress, which sets forth, that in 1839 the number of American ships lost in ordinary navigation was 1,059; and that in the month of December alone, of that year, 181 vessels and 179 lives were lost. Thus the number of lives lost in that month is nearly double the average annual loss by steamboat explosions, as deduced from what we have before stated.

During the five years ending with 1828, the ratio between the number of explosions and the number of exposures on steamboat from New York, was as 1 to 126,211; in the next five years ending with 1833, the ratio was reduced to 1 to 151,930; and in the following five years it fell to 1 to 1,985,787.

Comparisons of a similar nature between railroad and stage-coach conveyance have been often made. But we must not be entirely guided by numerical statements. We know that, when a marine or stationary engine-boiler does explode, or a train run out of its course, the consequences are frequently awful; it is, then, to diminish, as far as may be, the bare chances of accident, that our attention is to be directed, and the leading feature in Mr. Wilson's "improved steam machinery" shows that the contriver has been fully alive to the exigencies of the subject, and has most ingeniously met them. Mr. Robert Wilson, now of the celebrated Low Moor Iron Works, is already well known for his many mechanical improvements, amongst which is to be particularly noticed his improvement in the self-acting movement of Mr. Nasmyth's beautiful invention, the steam-hammer. In the several improvements described under his recent patent, he has evinced his usual ingenuity in grappling with the difficulties attending the confessedly troublesome subject of boiler explosions, as we shall now explain, in reference to the first four figures on plate 55.

The proximate causes of explosions are so various, that it would be a very difficult task to recapitulate them; but, apart from casualties arising from the use of defective materials, or ill-judged mechanical arrangements, we may safely reduce the number to two. These are, over-pressure, resulting either from a reckless overloading of the safety-valve, or the sticking of the valve to its seat; or shortness of water.

In a late number of the *Franklin Journal*, Mr. A. C. Jones very justly attributes the majority of accidents of this kind to gross neglect or ignorance—repudiates all nostrums, such as fusible alloys, floats, and balance-valves—and advises: first, to carry the water as high in the boiler as possible, without working it over into the cylinder; second, never to increase the steam pressure to allow for loss of power by leakage; and, third, if by any unforeseen cause the water gets too low, to avoid either pumping in more, or a sudden raising of the safety-valve, which will disturb the surface of the water, but to damp the fires at once, and allow the boilers to cool down below their working temperature. If time is an object, then throw in a slight quantity of water, and note its effects on the safety-valve; and if time has been allowed, the pump may be set to work, and a slow fire got up.

Now all this dissertation is totally misapplied, for the writer admits that the water *may* get too low by some unforeseen cause, and then it requires the very highest experience to decide upon the course to be pursued—such information, indeed, as is possessed by few engine attendants. With Mr. Wilson's arrangements, these unforeseen causes cannot injure the boiler, as (whether over-pressure or shortness of water) in either case the boiler fire is damped before the point of danger is reached. Every engineman knows that he can much easier maintain his steam pressure with his water-level low, than when it is full up to the regular safe level; therefore, he will always try to keep it down as far as he thinks the limit of danger will allow him.

Let us see how Mr. Wilson proposes to treat the matter. Fig. 1 on plate 55 is a vertical longitudinal section of a double-flue steam-boiler, with internal furnaces, to which boiler the apparatus is applied. A, Is a vertical pipe, like an ordinary feed-water pipe for low-pressure boilers. It is open at its lower end, B, which is set about one inch above the top of the furnace plates of the flue, C, and passes up through the top of the boiler to a height sufficient to obtain a column of water rather more than equal to the greatest steam pressure at which the boiler is intended to be worked. Near the upper end of this pipe, a branch, D, is formed upon it, forming a junction with the second vertical pipe, E, which passes downwards, outside the boiler end, and its extremity is bent to terminate in the front of the furnace at F. Or if two or more furnaces are fitted in each boiler, then a communication of the same kind must be formed with each of them. The height of the discharge branch, D, is such, that at the ordinary working steam pressure of the boiler, the water forced up the pipe by this pressure shall stand at some point beneath the branch, D. Should, however, the steam pressure be increased by any means beyond the due working pressure, the water will rise higher up the pipe, A, until, if the pressure still increases, it reaches the branch, D, when it will pass through the latter, and descend the pipe, E, and pour into the furnace.

This discharge of water will at once damp the fire, and thus reduce the steam pressure, whilst, at the same time, it will draw the attention of the engine-attendant to the fact, that all is not right with the boiler. The open end, B, of the pipe, A, in the boiler, is not exposed directly to the ebullition of the water, which would tend to derange the action of the apparatus, but is protected from this influence by insertion into a short length of wider pipe, G, open at top and bottom, the water standing at the same level within it as in the boiler. In this way the water contained in the guard-pipe, G, is kept in a comparatively undisturbed state, the stilling effect of the pipe being further assisted by its expanded or funnel-shaped upper end. In attaching this apparatus to a boiler, the branch, D, must be set at such a height as will allow of the obtainment of a column of water in the pipe, A, of a head pressure a little more than the pressure to which the safety-valve, H, is loaded—so that the latter may have a short range to permit it to work freely when in good order, without the protector or water-discharging apparatus being brought into play. Thus, when the slight difference between the head pressure in the water-pipe, A, and that to which the safety-valve is loaded, is exceeded, owing to the sticking of the latter, or from any other cause, then the protector acts at once upon the fire.

In the second system of action of this apparatus, to which reference has been made, when the water-level in the boiler falls below the open end, B, of the water-pipe, which would endanger the over-heating of the boiler flues, a portion of the water contained in the pipe at the time will drop out of the end, B, into the boiler, whilst the remainder will be forced up the pipe by the steam pressure. As the upper end of the pipe is closed, with only a small aperture to prevent its acting as a syphon, when water passes down its branch, D, the steam and water blown out will pass down the descending pipe, E, and damp or extinguish the fire. This discharge of steam being so contrived that it shall take place before the parts of the boiler liable to overheating are quite bare, the damping of the fire will always remove all danger of explosion or injury to the boiler, which may be again set to work after the supply to it of a proper quantity of water. The advantages of this apparatus are, that it renders the dangerous accumulation of steam impossible, being entirely free from valves or connections, which are liable to derangement, whilst it can never fail to call the attention of the attendant to any objectionable increase of pressure, and it will remove the cause of the over-pressure unassisted.

This arrangement is supposed to be suitable for a low-pressure boiler, but the same plan is applicable to high-pressures, if there are conveniences for carrying up the water-pipe to a sufficient elevation—as up the side of a chimney, or a high wall. In cases where it would be inconvenient to apply a very high water-pipe, the inventor proposes to

MPROVED STEAM MACHINERY.

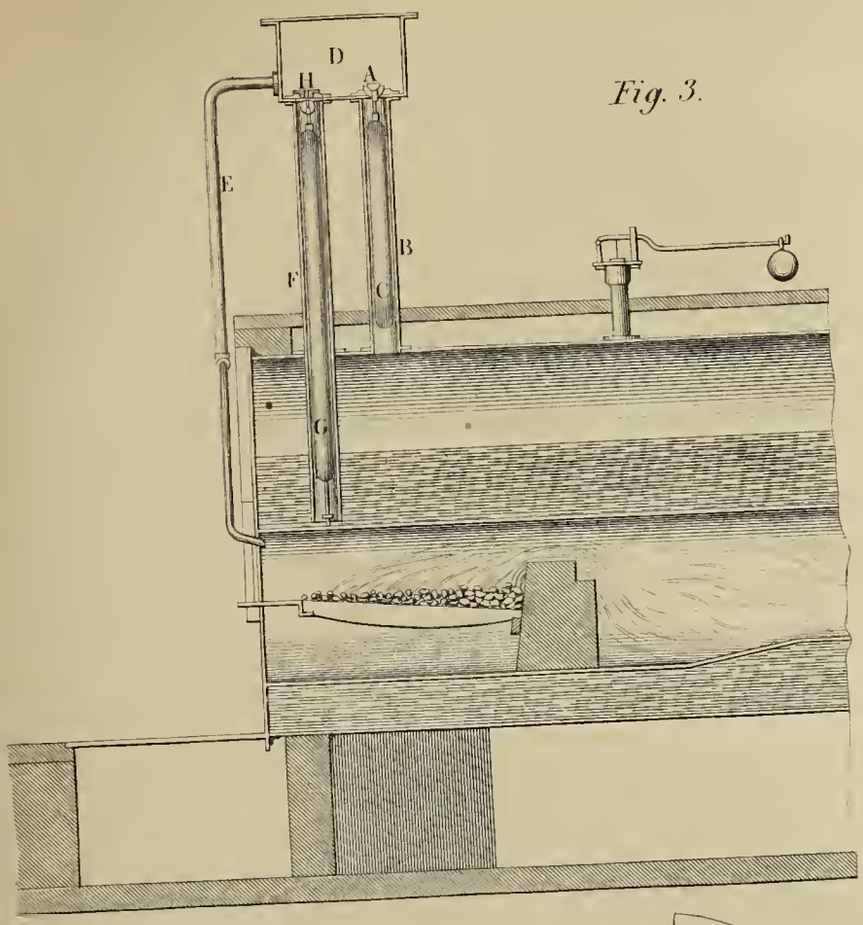


Fig. 3.

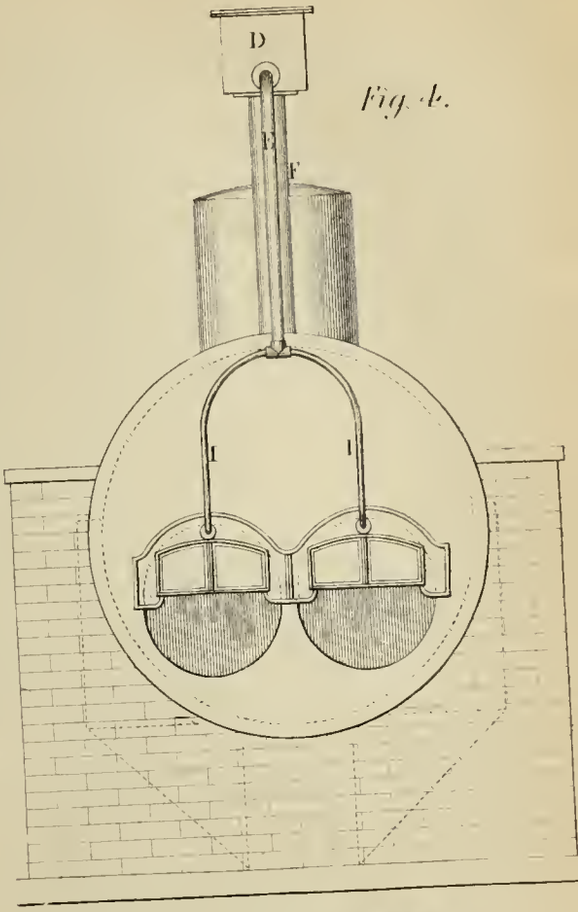


Fig. 4.

Fig. 11.

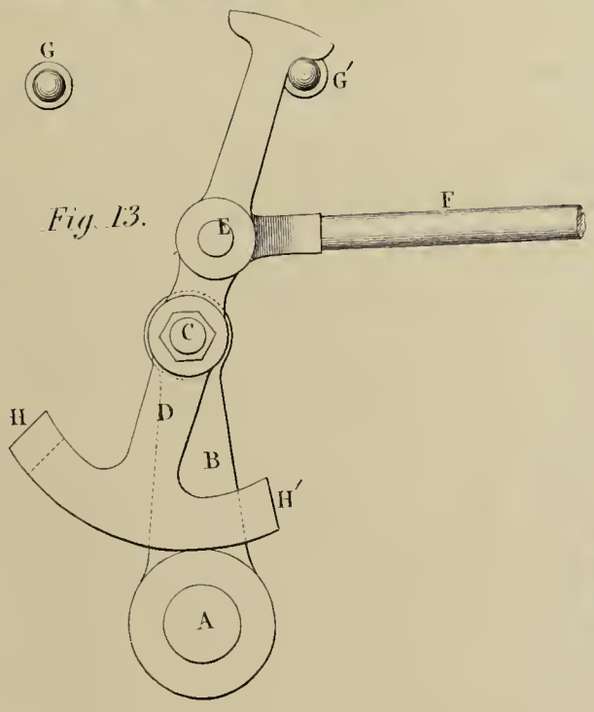


Fig. 13.

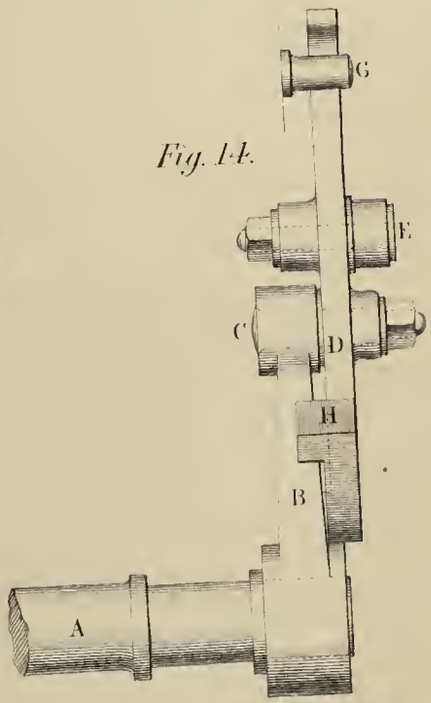


Fig. 14.

g. 12.

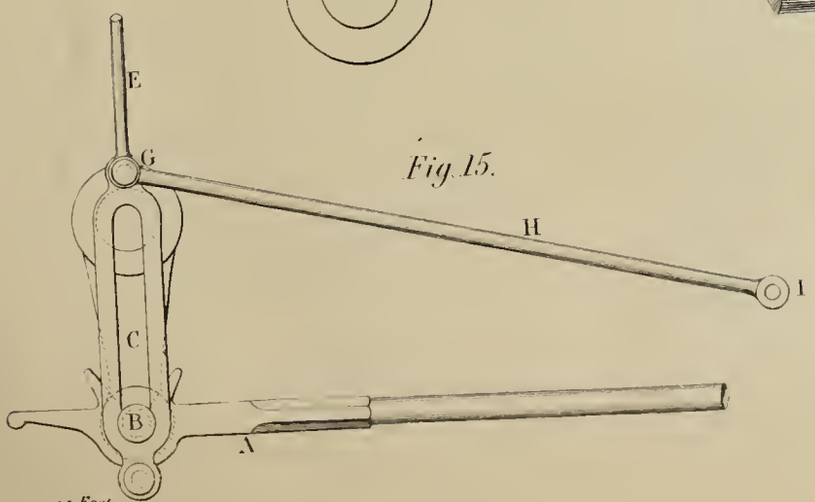


Fig. 15.

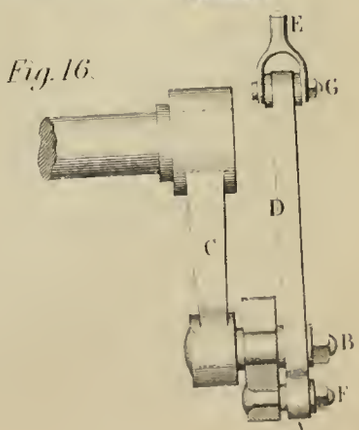


Fig. 16.

Scale for Fig 1.

25 30 35 Feet

20 25 30 Feet

8 9 Feet

Plate 55.

WILSON'S IMPROVED STEAM MACHINERY.

Fig 1.

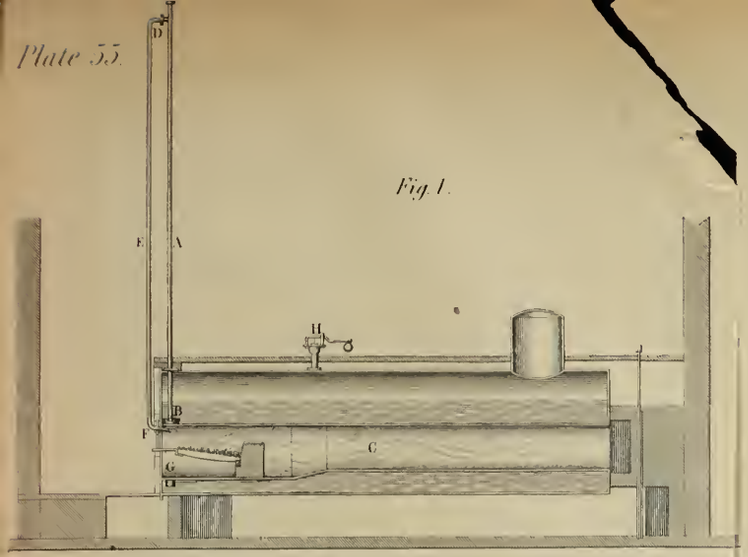


Fig 2.

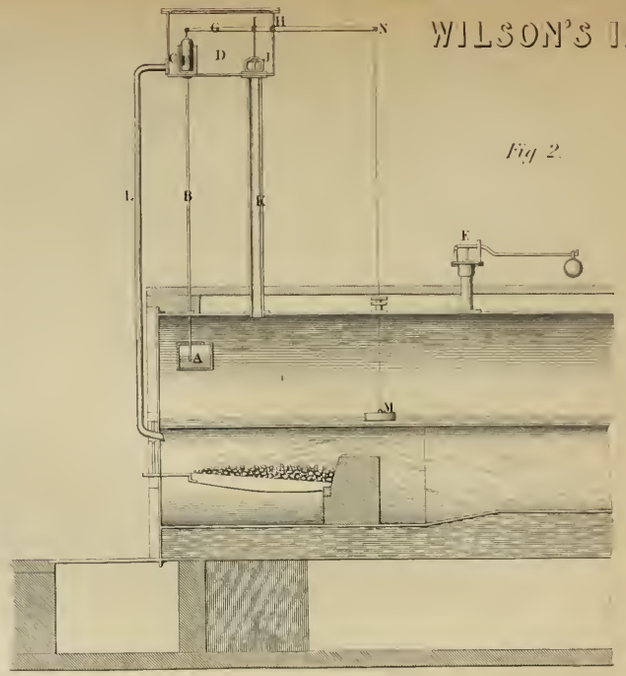


Fig 3.

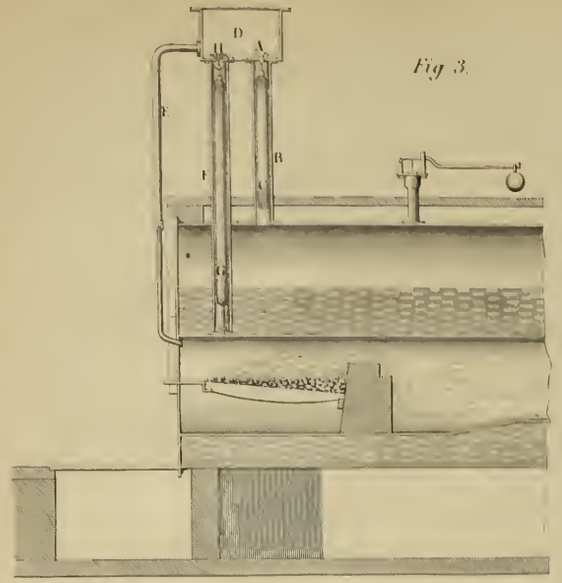


Fig 4.

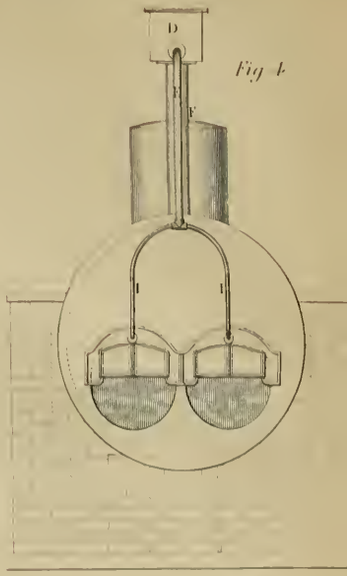


Fig 5.

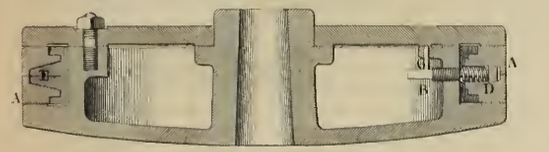


Fig 6. Scale ¾ ins. = 1 foot

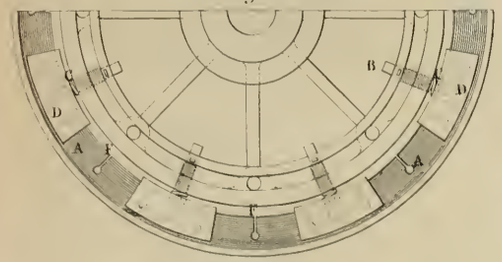


Fig 7.

Fig 8.

Fig 9.

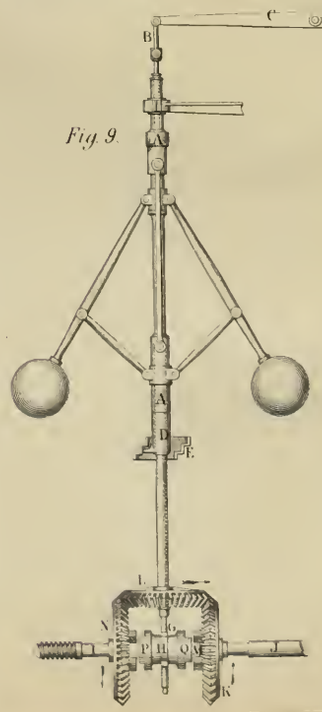


Fig 10.

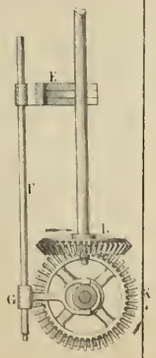


Fig 11.

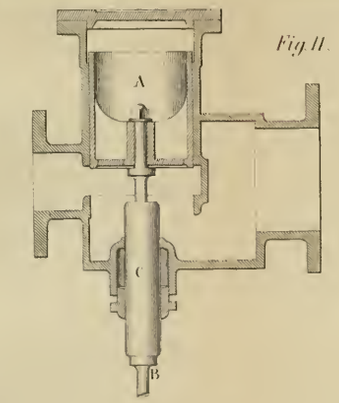


Fig 12.

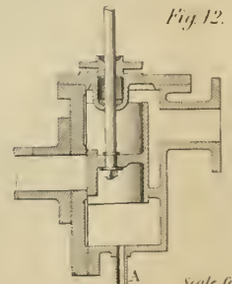


Fig 13.

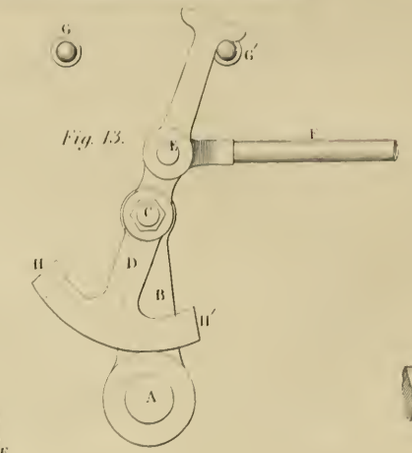


Fig 14.

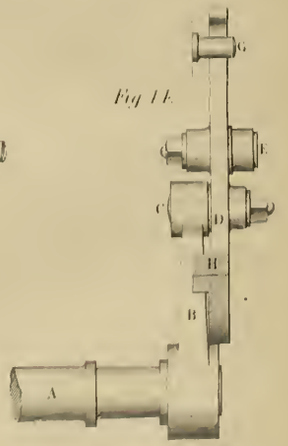


Fig 15.

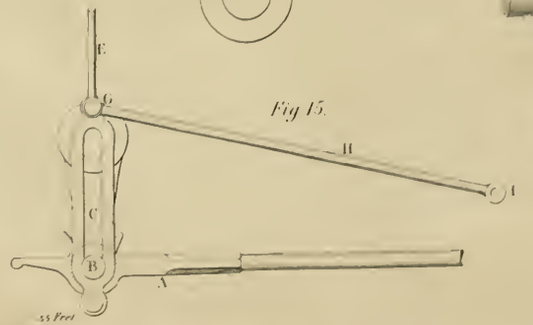
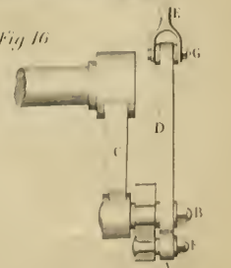


Fig 16.



Scale for Fig 1

55 Feet

Figs. 2 & 3

30 Feet

Remaining Figs

9 Feet

use a column of mereury, to he acted on by the steam pressure, aceording to an arrangement represented in fig. 2. In this figure, which is a longitudinal section of a steam-boiler of the same construetion as that represented in fig. 1, A, is a small iron cistern, placed inside the boiler. This eistern is filled with mereury, and has a small hole in the top, to allow the steam pressure to aet upon the surfaee of the mereury. A vertical pipe, B, of small bore, is inserted into this eistern, reaching nearly to the bottom of it, and passing upwards through the top of the boiler to a seeond small cistern, C, eontained in the elevated box or ehest, D. The elevation of the cistern, C, is such, that the head pressure of the mereurial column obtainable in the pipe, B, shall somewhat exeeed the proper working pressure of the hoiler. During the regular working of the boiler at a steam pressure below that to which the safety-valve, E, is loaded, the boiler pressure, aeting on the surfaee of the mercury in the chest, A, forces up a mereurial column in the pipe, B, to some point below the level of the eistern, C. Whenever, from any means, the steam pressure rises higher than this working pressure, the mercurial eolumn beeomes correspondingly elevated; and if the steam pressure still increases without hlowing off by the safety-valve, the mereury in the pipe, B, will be forced up into the eistern, C. This eistern contains a weight, F, whieh nearly fills it, being hung on the end of a lever, G, working on a eentre at H, and eonneeted at I, with a steam eseape-valve, J, on the top of the vertical pipe, K, forming a eommunieation between the top of the boiler, and the bottom of the chest, D. When the mereury is foreed up into the eistern, C, by the over-pressure, the weight, F, is floated or relieved hy it, so as to raise the valve, J, and allow steam from the boiler to blow off into the chest, D, and thenee to pass from it by the descending pipe, L, into the furnace to damp the fire. Again, if the water-level in the hoiler sinks too low, the lowering of the stone float, M, will draw down the end, N, of the lever, G, and raise the valve, J, to permit a similar diseharge of steam into the furnaee, to reduce the heat, and prevent the overheating of the boiler.

Fig. 3 is a longitudinal section of a boiler of the same class as is referred to in figs. 1 and 2; and fig. 4 is a front end elevation of the same, eorresponding. This arrangement exhibits the applieation of the safety prineiple hereinbefore deserihed, as earried out by means of valves of a different elass. The steam diseharge-valve, A, plaeed at the top of the pipe, B, is made with a hemispherical seat, and when the steam pressure raises this valve, with the weight, C, suspended helow it, the steam from the boiler is diseharged into the ehest, D, and thence, by the descending pipe, E, to the furnace. In the vertieal water-pipe, F, a metal float, G, is fitted to rise and fall in suitable guides. When the water-level falls too low, so as to uncover the open bottom end of the pipe, F, steam will rush up the pipe, displaciug the water eontained in the latter, and the float, G, being no longer supported by the water column, falls, earrying down the small ball-valve, H. This movement thus opens a passage for the steam to the ehest, D, whenee it is diseharged into the furnace by the pipe, E. The end elevation, fig. 4, shows the two braneheS, I I, passing from the vertical pipe, E, to each furnaee.

It is probable that a eombination of the two high-pressure plans—the mereurial column, with the elevated mereury cistern, and the metal float, the latter heing plaeed in a wide pipe, say of seven or eight inches diameter—might be found a useful arrangement. The elevated chest, containing the mereury cistern and valves, would be made with a double bottom, the upper division of which would have in it the valves both of the metal float and the weighted lever, so that the water and steam-escape would oeeur exaetly as with the open pipes.

This principle of boiler-protector is clearly applicable to marine boilers, where it is of the utmost importanee to seeure all the safety that our meehanical resources can furnish. In such situations, the height of the pipes would be a elear guarantee to the public that the steam pressure is not greater than the indieation whieh they afford.

The effieieney of the action of the plan has heen well exhibited at the Low Moor Works, where it has been tried for nearly a year, every one of the arrangements having been in action. One firm in Yorkshire is having no fewer than seventeen boilers fitted in this way. The pipes are now made with turned and bored faueet joints, to admit of easy removal for cleansing.

The remaining portions of Mr. Wilson's inventions refer to various details of steam machinery.

Fig. 5, on our plate, represents a vertieal seetion through the centre of a new metallic piston, and fig. 6 is a half-plan of the same, corresponding, with the cover removed. The metallie packing rings, A, are so arranged that they adjust themselves perfeetly to the internal surface of the eylinder, accordingly as the ruhbing surfaces wear; and by means of the adjusting serews, B, and the helical springs, C, the packing rings may be expanded or tightened up against the cylinder's surfaee with any required intensity of pressure. The helical springs upon the adjusting screws are inserted into reeesses in the wedges, D, which aet by their external inelines upon the inclines at E, on the paeking rings. The angles of these inclined surfaces are sueh as to prevent any jam in working, so that the paeking rings, A, are retained in elose eontact on their upper and lower surfaces with the body and cover of the piston, whilst they are free to slide backwards and forwards to allow for any inequality in the internal surfaee of the eylinder. The paeking rings are cut through in one plaee, and are also cut partially through on their inner edges, as at F, to render them more easily adjustable by the springs. The serews, B, are prevented from relaxing their pressure in working by the keepers, G, whieh act as holders to prevent any revolving movement.

Figs. 7 and 8 show an improvement in pump buekets, whieh is particularly applieable to buekets for air pumps and eold water pumps, and consists in the application of self-adjusting metallic paeking, which acts without the assistance of serews or springs. Fig. 7 is a vertical seetion of the bueket, and fig. 8 is a half-plan, eorresponding. The body of the bueket is formed with a bottom flange, A, on which the segmental packing ring, B, rests, and over this ring is the solid paeking ring, C. The upper surfaee of the flange, A, is turned with a slight incline, about one in four, and the lower edge of the packing ring, B, is turned to fit. The upper edge of this ring has also an incline, D, turned upon it, and it is then cut through into three or more segments, having a stop-pieee let in at each joint in the usual manner. The solid ring, C, is turned slightly less in diameter than the bore of the pump or working barrel, so as to clear its surface; and its lower edge has an incline formed upon it, to correspond with the ineline on the upper edge of the packing segments. When the segments, B, are placed on the bucket in its barrel, the inelined surface of the hottom flange, A, eauses them to slide downwards, expanding them against the barrel; and the weight of the solid ring, C, with any superincumbent load, acting through the inelined surfaees, retains the segments, B, in close contact with the barrel, or eylinder, in whieh the bucket works.

Another improvement refers to the regulation of the motion of steam-engines, and is applieable to all stationary engines fitted with the ordinary governor, the objeet of sueh improvement being to seeure a uniformity of rate, whether the engine has upon it a light or a heavy load. This is aeeomplished with the ordinary governor, either by means of the throttle or expansion valve. The governor aets in the usual manner, by the expansion or contraetion of its pendulous arms, whieh movement correspondingly affeets the steam inlet ports, in the inerease or reduction of the steam supply; but, in addition to this aetion, it brings into play another meehanical arrangement, the effeet of which is to inerease or reduee still farther the steam supply, until the engine is again brought to its proper rate, whatever the load upon it or the steam pressure may be. Fig. 9 is a complete elevation of a governor, to whieh the apparatus is added; and fig. 10 is a detached elevation of a portion of the governor spindle, with the neeessary gearing. The slide-bushes, A, are eonneeted by the links, B, to the throttle-valve lever, C, in the usual manner. The lower slide-bush, A, has attaehed to it a eam or tappet, D, arranged to work a tappet-gab lever, E, fast upon the upper end of the eluteh-lever shaft, F, the lower end of whieh shaft carries a eluteh-lever, G, working the horizontal sliding-elutch, H, earried on the horizontal reversing shaft, I. In a line with this reversing shaft is a seeond shaft, J, the extremity of which has keyed upon it the bevel wheel, K, and this shaft thus drives the governor spindle through the bevel wheel, L. The reversing shaft, I, whieh is extended beneath the governor spindle to the point, M, carries a loose bevel wheel, N, corresponding to the fast wheel, K, and this wheel, N, being in gear with the wheel, L, on the governor spindle, revolves constantly in a direction opposite to the driving shaft, J, the relative movements of the set of wheels being indieated by the arrows. The governor is represented in the position whieh it would take up when the engine is working at its proper speed; but if, from any cause, its rate is inereased, then the expansion of the pendulous arms will push up the slide-bushes, A, and contraet the throttle-valve passage by the lever, C. At the same time, the tappet, D, rising up with the lower slide-bush, A, will, in its revolution, throw to one side the gah-lever, E, by pushing against one side of the stepped fork-pieee, which movement will shift the end, P, of the clutch, H, into gear with the loose wheel, N. As this eluteh slides on a fixed feather in the shaft, I, this movement eonneets the loose wheel, N, with the reversing shaft, I. This shaft is stationary until the eonneetion takes place; but, immediately on the movement of the eluteh, it receives the motion of the hevel wheel, N, and heing in eonneetion with the throttle-valve, or the cam of the expansion-valve, the steam admission is in this way further decreased, until the engine regains its true rate. The depression of the slide-bushes, A, by any reduetion in speed, aets, on the contrary, on the opposite side of the stepped fork-pieee of the lever, E, and puts the end, Q, of the eluteh, H, into gear with the wheel, K, on the driving shaft, when the reversing

shaft, I, is put in motion, in the same direction as the driving shaft, and increased steam admission is thus given.

Mr. Wilson has introduced a modification of expansion-valve, in which he so arranges the valve that the steam pressure shall move it in one direction, whilst the movement of the engine gives the reverse action. Fig. 11 represents a vertical section of a valve-chest, with a valve so arranged. In this modification, A is the expansion-valve, fast upon the vertical rod, B, which rod carries a piston or plunger, C, beneath the valve, and working through a stuffing-box in the lower side of the valve-chest. The valve, A, is pushed upwards by a cam or other movement acting on its rod, B, and when released from this upward action, the steam pressure acting on the upper end of the plunger, C, gives the return action, and brings down the valve without the assistance of springs or weights. This arrangement is also applicable to D valves, which may in this way be made to act as expansion-valves, by working the two valves separately, and in a manner similar to the working of Cornish valves, when worked by a cam, with the difference that, in the present case, the steam opens the valves to admit steam, and the cam or other motion shuts them. On this principle the D valve may be used as a single expansion-valve, as is delineated in the vertical section, fig. 12. With this valve, a pipe, A, may be carried from the lower side of the valve-chest to the condenser, when steam of very low pressure may be used for driving the engine, such pressure being also sufficient to move the expansion-valve.

Another branch of improvement refers to slide-valve gearing, and consists of an arrangement of mechanism whereby a quick movement may be given to the valve at any given portion of its stroke—an advantage which cannot be secured in the ordinary eccentric movement. Fig. 13 is a side elevation of the apparatus, and fig. 14 is a corresponding elevation taken at right angles to it. A, Is the valve rocking shaft, carrying a lever, B, the pin, C, of which lever is jointed to an additional double lever, D. At E, a second eye is formed on the lever, D, to receive the pin of the eccentric rod end, F, working the valve. The upper end of the lever, D, is formed of a T shape, and on each side of it is a fixed stop, G G′; whilst its lower end is formed segmentally, with two angular stop projections, H H′, one on each side of the lever, B, on the rocking shaft. Previous to the upper end of the lever, D, coming in contact with either of the stops, G G′, if the eccentric rod is moving in the direction of the arrow, the projection, H′, on the segmental end of the lever, D, is brought into contact with the side of the lever, B, as shown in the drawing, and the pull of the eccentric rod then causes the apparatus to act on the rocking shaft, as if it were a plain lever of the length from E to the centre of the rocking shaft. The further traverse of the eccentric rod brings the upper end of the lever, D, into contact with the stop, G′; the lever, D, then becomes, for the time being, a lever of the third order —being held at the top by the stop, G′, whilst the pull of the eccentric rod causes it to act upon the lever, B, through the pin, C. This will cause the lever, B, to move at double the rate which it had previous to the stop, G′, coming into action; and this continues until the opposite projection, H, of the lever, D, comes in contact with the latter. In the return traverse of the eccentric rod the same action occurs, the slow motion being changed to a quick one, as before—this quick movement being brought into play at the instant of the commencement of the exhaust.

The last point of improvement is an arrangement for instantaneously stopping the movements of steam-engines in case of accident. Fig. 15 is a side elevation of a portion of a rocking shaft, with its actuating lever, to which the stop mechanism is attached; and fig. 16 is a corresponding front elevation. A, Is the eccentric rod, the forked gab of which is in gear with the pin, B, on the rocking shaft lever, C. D, Is a straight slotted link suspended from a rod, E, and attached by a bolt, F, at its lower end, to the eccentric rod gab. This link is placed so that the prolonged pin, B, of the lever, C, projects through its slot. At G, a rod, H, is jointed to the link, the opposite end of this rod being arranged to turn on a fixed centre at I. As delineated in the figures, the eccentric rod is in gear with the rocking shaft lever of the valves; but if, for any reason, it is necessary to stop the engine quickly, nothing more is necessary than to lower the link, D, which thus disengages the eccentric rod from the pin, B. The slotted link in this movement slides down the pin, B, and its upper end being under the command of the rod, H, which turns partially on its centre, I, the lever, C, will be forced by this rod into such a position as to cover up the cylinder steam-ports with the valve. This prevents the further supply of steam to the cylinder, and, if the valves are properly set, their exhaust-ports will be slightly open to the condenser, allowing the steam to escape gently into the latter, and the engine will come to a stand in little more than a single revolution. The same movement may be connected to the injection-valve, so as to shut off the injection water. The apparatus may be placed in connection with any part of the works where the engine is situated, by a bell wire, or other light and simple communicator; and, if necessary, a bell may be rung by it in each apartment, notifying in each that the engine is about to stop The stop apparatus may also be made to work in connection with the governor, so that, if the engine's rate should be unduly increased, the governor will itself throw the valves out of gear.

GALVANISM.

By Mr. R. Smith, Blackford.*

Our knowledge of electricity is, comparatively speaking, of very recent origin. It appears to have been utterly unknown to the philosophers of ancient times, for the entrance of the science into physics may be said to have taken place about the commencement of the eighteenth century.

For a long period it was supposed that the electrical energy could only be excited by friction, but subsequent discoveries have shown that it may be effected chemically—by magnetism, electro-dynamic induction, heat, and by the muscular action of certain fishes. Hence the science has been divided into common electricity, galvanism, electro-magnetism, magneto-thermo, and animal.

Galvanism presents one of the many examples of magnificent discoveries under accidental and trivial circumstances. A recently-killed frog was lying on the laboratory table of Galvani, a professor of anatomy at Bologna, whilst a pupil was experimenting with an electrical machine. During the operation of the machine, the blade of a knife held by the experimenter happened to touch a limb of the frog, when it was immediately thrown into violent convulsions. Galvani, being from home at the time, did not see this occurrence, but, on his return, received an account of it from his wife; and, being struck with the detail of so remarkable a phenomenon, immediately repeated the experiment. He observed that the muscular contractions only took place when a communication was made between the prime conductor of the machine and the nerve, with a knife or other conductor. Going a little deeper into the subject, he found that the contractions could be effected without the electrical machine, by placing a piece of zinc upon the nerve, and a piece of copper upon the muscles, and forcing a metallic communication between the two metals. Galvani was of opinion that the muscles and nerves contained the electricity, and that the metals were merely conductors; and, consequently, came to the conclusion, that the muscles and nerves comprise opposite electrical energies, similar to the surfaces of a Leyden jar, and that the contractions were occasioned by the electric current passing along the conductor, between the muscle and nerve, to restore the electric equilibrium. This was in 1790.

Much attention was excited by these experiments throughout the philosophical coteries of Europe—some inclining to the idea that the action arose from a singular modification of the electric fluid, others that it was caused by a new and unknown agent. Volta's discovery of the pile which bears his name, however, established the identity of electricity and galvanism, and furnished a clue to the solution of the question at issue. Volta maintained that the electricity was generated by the metals, and, in its passage along the nerves and muscles of the animal, produced the resulting contraction. Doubtless this was the real state of matters as far as these experiments went; but Galvani's notion was not so vague as may be casually supposed, for not a few of the most eminent men of the present day are of opinion that the brain is possessed of electric power, analogous to that of a galvanic battery, and that the electric fluid, which is supposed to be identical with nervous energy, is transmitted, through the channel of the nerves, to all parts of the system.

Considerable light has been thrown upon this subject by the late discoveries of Mr. Alfred Smee. This indefatigable searcher has shown that galvanic or voltaic piles may be formed of animal substances, such as blood and muscular fibre, sufficient to cause a deflection of the galvanometer. He has also experimentally proved, that not only vision, but also taste and smell are voltaic phenomena.

When a needle is inserted into the choroid of the eye, and another into the muscles of the eyeball, a deflection of the galvanometer at once takes place, when a strong light is thrown into the eye. Again, if we place in a glass tube, bent into the form of a U, a solution of per-nitrate of iron, and two platinum wires, one in each end of the tube, the galvanometer shows no deflection; but as soon as a little infusion of meat is put into one side of the tube, the galvanometer exhibits an electrical action. This new and interesting branch of the science has received the name of Electro-Biology—the voltaic mechanism of man.

The present state of galvanism as a science may be briefly described, in reference, first, to the arrangements from which galvanic power is obtained; second, to its physiological effects; third, its effect in the production of chemical decomposition; and fourth, its connection with electro-magnetism.

* Read before the Andersonian Institute, Perth.

CURVES

Shewing the ratio of the

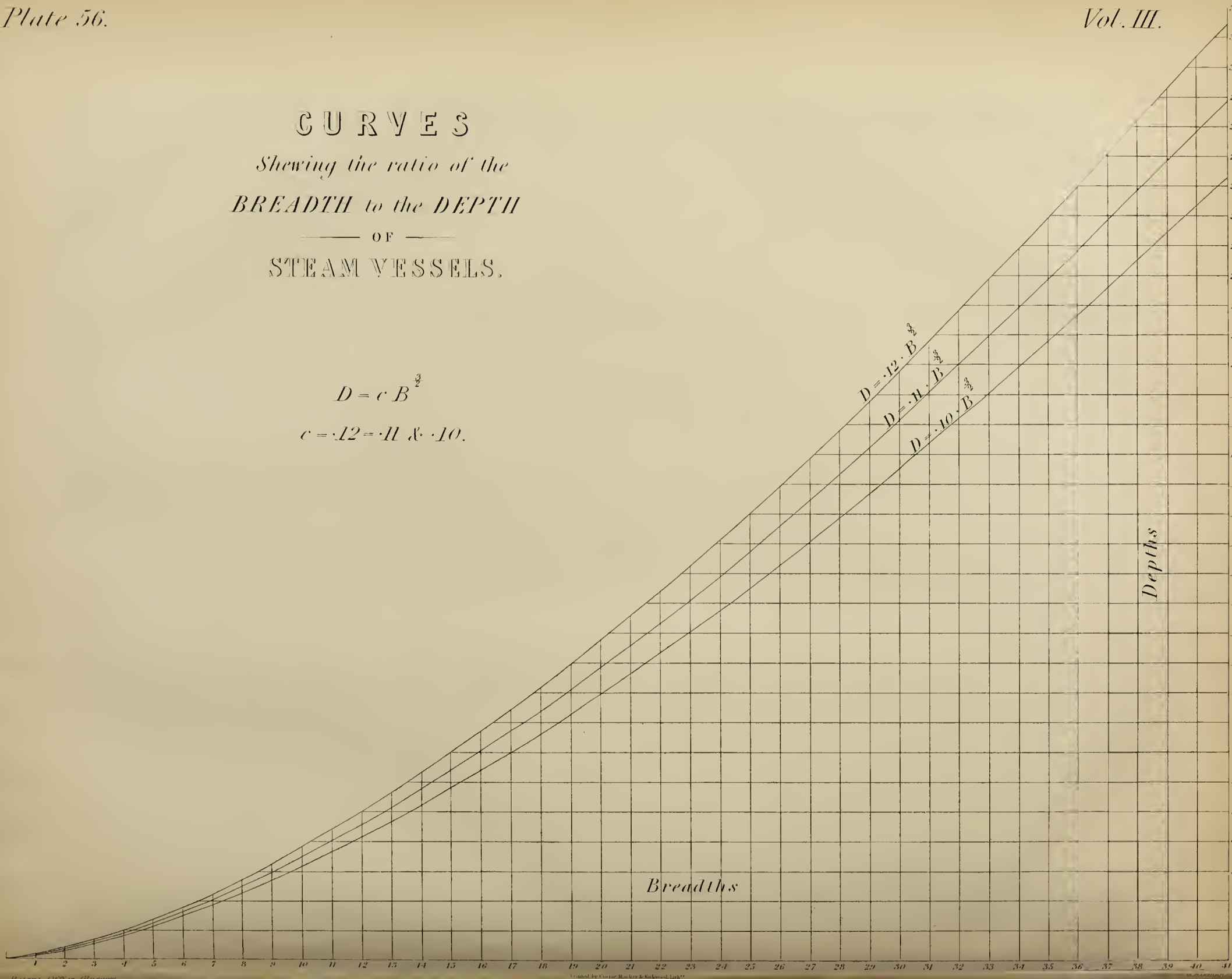
BREADTH to the DEPTH

— OF —

STEAM VESSELS.

$$D = c\,B^{\frac{3}{2}}$$

$$c = \cdot 12 = \cdot 11 \;\&\; \cdot 10.$$



Frictional electricity and galvanism are due to the same power, excited under different conditions; but common electricity differs from that obtained by the galvanic battery, with regard to its intensity and quantity—the strong attractive and repulsive effects of the former being produced by a slight quantity of insulated electricity of high tension. In the latter, the electricity is very abundant, but never attains to what may be called a high degree of tension, and its effects are exhibited whilst flowing in a continued stream along bodies capable of conducting it.

A vast number of different arrangements have been invented for exciting galvanic action, but all belong to one of the two kinds—simple and compound. The simple galvanic circle is formed by placing a plate of zinc and one of copper in a vessel of water, and connecting the two with a wire. In this way galvanism is excited, but so feebly that the galvanometer alone indicates its presence. If a little sulphuric acid is now added to the water, the electric current becomes more powerful, and hydrogen gas is evolved at the surface of the copper. In this case, the circle being formed of zinc and copper, with dilute acid interposed, so long as the circle remains closed or unbroken, a current will pass from the zinc, through the liquid, to the copper, and from the copper, along the conducting wire, to the zinc. When the circle is broken by the removal of the wire placed between the zinc and copper plates, the current at once ceases. A compound circle is composed of a series of simple circles. The voltaic pile is a compound arrangement, and is constructed by placing pairs of zinc and copper plates one above the other, with interpositions of pieces of cloth, wet in a solution of common salt. The voltaic pile is seldom employed now, as other and much superior modes of forming galvanic combinations have been devised by Cruickshanks, Wollaston, Children, Hare, Daniell, Mullins, Bachoffner, Smee, Grove, and others.

Mr. Faraday has shown that the presence of water is not essentially necessary in the composition of a galvanic battery—as liquid compounds, such as metallic chlorides, fluorides, or iodides, if decomposable by the galvanic influence, and acting with greater chemical energy on one of the metals than on the other, may be used instead.

The physiological effects of galvanism are similar to those produced by the electrical machine, if we take into account the duration of the one, and the intensity of the other. When a part of the body is made to form part of the circuit of a battery in action, a distinct shock is felt every time a connection is made with the extremities of the battery; and if the battery is powerful, an intense aching pain is felt during the time the current is passing through the body. The effects of galvanic electricity may be exhibited without a battery, by placing a piece of zinc between the gums and upper lip, and a piece of silver upon the tongue, the contact of the two metals producing a flash of light, with a peculiar taste.

Of all galvanic experiments, the most wonderful are those which have been performed on the bodies of criminals after death, the convulsions produced being so excessive, that the experimenters believed that life had been restored under most intense suffering. A remarkable analogy is found to exist between galvanic energy and nervous influence—so much so, that the former may be substituted for the latter, as proved by Dr. Philips in his experiments with rabbits. When an incision was made in the neck of the rabbit, so as to divide the eight pairs of nerves subservient to digestion, the food eaten immediately before the operation remained without alteration in the stomach. In other cases, the galvanic energy was distributed to the stomach by placing one of the conductors on the nerves below the incision, and the other upon the skin opposite the stomach. After continuing the action for twenty-six hours the rabbits were killed, and the food in the stomach was found to be perfectly digested. Mr. Noad observes, "The general inferences deduced by Dr. Philips from his numerous experiments are, that voltaic electricity is capable of effecting the formation of the secreted fluids, when applied to the blood, in the same way in which the nervous influence is applied to it, and that it is capable of occasioning an evolution of caloric from arterial blood, when the lungs are deprived of the nervous influence by which these functions are impeded and even destroyed; when digestion is interrupted by withdrawing this influence from the stomach, these two vital functions are renewed by exposing them to the influence of a galvanic trough." "And," says Dr. Philips, "galvanism seems capable of performing all the functions of the nervous influence in the animal economy, but obviously it cannot excite the functions of animal life, unless when acting on parts endowed with the living principle."

Under our third head, we come to the chemical effects produced by the galvanic battery. When the terminal wires are brought near each other, a spark is seen to pass between them, and if we establish a communication by means of fine wires, although these wires may be made of the most refractory material, they will be fused, burning with a vivid light, under a powerful battery. Gold burns with a white light tinged with blue; silver has a very brilliant light of a green tint; copper, bluish white, emitting red sparks; lead, a beautiful purple; and zinc, a brilliant white, inclining to blue, and fringed with red. The chemical effects of galvanism convey to the mind a most striking impression of its wonderful and mysterious power. By its agency, Sir H. Davy was enabled to demonstrate that the alkalis, potass, and soda, are the oxides of two new metals, and that a number of the other alkalis and earths are metallic oxides; the metals of which are possessed of the most singular properties, analogous to potassium and sodium. This he revealed to the world in 1807. When water, or a saline solution, is made to form part of the circle, the liquid is decomposed, the elements being given up in obedience to certain laws. Thus, when water is subjected to the action of the electric current, it is separated into oxygen and hydrogen, the oxygen being developed at the anode, or positive pole of the battery, and the hydrogen at the cathode. Similarly, the acid contained in a saline solution accumulates at the anode, and its alkaline base at the cathode. Oxygen, acids, chlorine, bromine, iodine, fluorine, and all electro-negative bodies, are determined to the anode; whilst hydrogen, alkalis, metals, and all electro-positive substances, appear at the cathode. It is to be remembered, that in a compound battery, the zinc end is the positive pole, and the copper or silver the negative. In a simple circle, it is the reverse.

We have now arrived at the fourth division of the subject, the connection between galvanism and electro-magnetism. The discovery of this relation by Oersted of Copenhagen, in 1819, opened up a new field for discoveries, now one of the most fertile and extensive to be found in the annals of scientific research. The fact observed by Oersted was, that when a magnetic needle was brought near the connecting medium of a closed galvanic circle, it was instantly deflected from its natural position, and took up a new one, depending on the relative position of the wire and needle. This celebrated discovery laid the foundation of electro-magnetism.

The magnetic power emanating from an electrical conducting wire, is entirely different to every other force in nature, as regards its mode of action. This has been termed a tangential action, the peculiarity of which is, that it produces a motion in a circular direction. When the conducting wire is vertical, and the current made to descend through it, the north pole of a magnet will have a tendency to move round it from left to right, whilst a motion from right to left is given to the south pole by a similar current. If the conducting wire is allowed to remain in the same position, the current being reversed, the magnetic action will also be reversed. Dr. Faraday, reasoning upon the relative motions of the needle and electrified wire, concluded that the electric conductor ought to revolve about the pole of a magnet, and the pole of a magnet about the conductor.

These investigations led to various contrivances for producing electro-magnetic rotations; and the knowledge of the fact, that soft iron becomes powerfully magnetic when submitted to the influence of a continuous galvanic current, established the theory of the identity of electricity and galvanism. The same may be said of the other imponderables, which, until lately, were considered to be distinct in their natures; now, however, everything points to the conclusion that light, heat, electricity, galvanism, and magnetism, are simply modifications of the same subtle and mysterious agent.

ON THE MEASUREMENT OF THE DEPTH AND TONNAGE OF VESSELS.

(Illustrated by Plate 56.)

Our experience in steam-ship building has taught us, that it is useless to carry the depth of vessels beyond a certain limit, for they then become crank or unstable. Still, in most cases, it is desirable that they should be as deep as is consistent with safety; for thereby their longitudinal strength is greatly increased, and space for cargo is obtained with fewer materials than by any other modification of build. For this and other reasons of less importance, steamers are generally made as deep as the builder considers safe.

These depths follow no direct proportion of the breadth, but increase in a greater ratio than the latter. Every shipbuilder finds this to be the case; yet most works on naval architecture either take no notice of the relation existing between these two dimensions, or fix it empirically, by making the depth one-half, two-thirds, or some other fraction of the breadth; but these general rules are quite useless in their application to all sizes of vessels.

The experience gathered from the failures of vessels which have been built too deep, and of those which might have been deeper, has led to

the present practice of making the depths greater as the vessel increases in breadth; but this law of increase is not well determined. It may be solved practically, however, by laying off, from a point on a straight horizontal line, the breadths of a number of successful vessels, setting up, from these breadths, the depths of each at right angles. Then a curve passing through these points of depth will give the depth of any other vessel of similar construction, the breadth of which comes within the curve.

This plan was tried upon the dimensions of a number of iron steamers built on the Clyde—the breadth varying from fifteen to thirty feet—and the result so nearly coincided with the parabolic curve, that I now submit it as a rule for assisting the naval architect in determining the depth of any vessel, the breadth being given. It is as follows:—

The *depth* (D) = a constant number (*c*), multiplied by the square root of the cube of the *breadth* (B); or in another form, $D = c B^{\frac{3}{2}}$, & $c = \frac{D}{B^{\frac{3}{2}}}$. This constant number, *c*, every shipbuilder may, if he pleases, determine for himself, from the results of any successful vessels he may have built. For the iron paddle-steamers referred to above, *c* comes nearly equal to ·12, or $\frac{12}{100}$; therefore, I take it that the depth of flush-decked iron paddle-wheel steamers, in general, should never exceed $\frac{12}{100}$ of the square root of the cube of the breadth. This depth is measured from the outside of the frame to the line joining the gunwales; but it would be advisable, in applying this rule, or in comparing the depths of vessels, not to measure them in the centre line, but say at one-fourth of the breadth on either side. This will enable the constructor to make the bottom either flat or rising, or any form he pleases. The comparative table in plate 56, with the curves drawn for three separate constants, may save a little calculation, by showing the depth when the constant is settled upon.

Whatever may be the cause of the depths of steamers increasing more rapidly than the breadths, the fact is before us; and this increasing depth is the principal reason why the buying and selling of vessels by the ton (builder's measurement) is a most absurd way of making a bargain, for the practice assumes that the depth bears a constant proportion to the breadth, whereas in reality the relation varies.

The cost of building vessels evidently varies with the surface multiplied by the thickness, and this has been found to be, very nearly, as the length × the breadth × the depth. The ton was, doubtless, meant as a unit for the measurement of this capacity. The following table, however, will show its inaccuracy, at least as regards steamers. The first column represents the breadth; the second, the depth, calculated by the rule $D = \frac{12}{100} B^{\frac{3}{2}}$; the third, the breadth, multiplied by the half-breadth, divided by 94, or $\frac{B^2}{188}$; when this is multiplied by the length, or rather by $L - \frac{3}{5} B$, the old tonnage is found. The fourth is the breadth × the depth, or $\frac{12}{100} B^{\frac{5}{2}}$; when this is multiplied by the length, the capacity in cubic feet is found. The fifth is merely the fourth divided by 100, assuming 100 cubic feet to be equal to a ton, which it really is, in vessels of 20 feet beam, and 10·68 feet deep.

1	2	3	4	5
Breadth.	Depth.	$L - \frac{3}{5}B \times \frac{B^2}{188}$ = Old Tonnage.	$L \times \frac{12}{100} B^{\frac{5}{2}}$ = Capacity in cubic ft.	Col. 4. / 100
B	$\frac{12}{100} B^{\frac{3}{2}}$	$\frac{B^2}{188}$ or tons per ft. of length.	$\frac{12}{100} B^{\frac{5}{2}}$ or cubic ft. per ft. of length.	
15	6·96	1·2	104·4	1·044
20	10·68	2·13	213·6	2·136
25	15·	3·33	375·	3·75
30	19·68	4·78	590·4	5·904
35	24·84	6·52	869·4	8·694

By comparison of the columns 3 and 5, the defects of the old tonnage measurement are apparent. A vessel of 20 feet beam, will measure (col. 3) 2·13 tons per foot of length; one of 35 feet beam, will give 6·52 tons per foot—omitting $\frac{3}{5}$ths of the breadth; but the actual capacity of these two will in all probability be, for the former, (col. 4) 2·13, and for the latter, 8·6 or 8·7 tons per foot of length. This last sum is nearly $\frac{1}{3}$d larger than would be expressed by the old tonnage—the discrepancy arising from the actual depth being much greater than that supposed by the law. The cost per ton will therefore vary with every breadth, if the depth is any other than the proportion ($\frac{1}{2}$ breadth) assumed by the law.

According to the scale of depths marked in the table—if a vessel of say 20 feet beam, costs £10 per ton = (col. 5) to £21. 3s. per foot of length, one of 35 feet beam will cost about £13. 2s. per ton, or $\frac{1}{3}$d more = (col. 5) to £86 or £87 per foot of length; whereas, if the tonnage varied according to the capacity, measured by the length, multiplied by the breadth and the depth, the cost per ton would in all cases be constant, or rise and fall with materials and wages.

As vessels pay dues for the use of harbours, docks, and lighthouses, it would only be fair that they should be charged in accordance with the space which each occupies, and this is evidently the length multiplied by the breadth and the depth, external measurement, altogether irrespective of the form. For what have River Trustees or Dock Companies to do with the form of any vessels entering their harbours or rivers? The entrances and accommodation spaces require to be large enough to take in the length, breadth, and depth of the vessels, and ought to be paid for accordingly.

The present tonnage law, although it very nearly gives the internal capacity of the vessel, is of no other use; for shipbuilders cannot estimate by it the cost of vessels intended to be built. In fact, a very nice measurement of the carrying power of the vessel is not required by the Custom-house authorities, Dock Companies, or Lighthouse Boards.* It is only necessary that whatever rule is enforced should be fair and uniform for all vessels, and this may be accomplished by multiplying the length, breadth, and depth—external measure—together, adding the dimensions of any poop or forecastle, and dividing by 100. The length should be taken at about the half-depth, and the breadth at the widest part.

J. R. N.

FORMULÆ FOR THE PRESSURE OF SATURATED STEAM IN RELATION TO THE TEMPERATURE.

The admirable investigations of the constants relating to the economical employment of steam as a motive agency, conducted by M. Regnault, by order of the late French government, may be fairly considered as affording conclusive data of all the phenomena included within the range examined, until some new discovery in science, of a fundamental character, shall offer additional facilities of research. The direct methods of trial and observation may, in the meantime, be regarded as exhausted, and to have yielded the full measure of accuracy of which they are susceptible. It therefore only now remains to give effect to the results obtained by reducing them to rules of calculation, of ready practical application, and the most simple of which the relations admit.

One of the most important, if not the most important, of those relations, is that subsisting between the temperature and the elasticity of the steam in contact with the fluid from which it is generated. As yet this relation can only be expressed approximately, and by empirical formulæ. The true law of connection—and there cannot exist any doubt but that an absolute law does exist—has hitherto eluded analysis, and we are compelled to rely, in our most important calculations, on rules which represent the law more or less distantly, and usually over a very small portion of the curve of pressures. We have a multitude of such rules, and some of them represent very exactly the data on which they are founded; but as these data are much less complete than those obtained from the elegant and extended researches of M. Regnault, it becomes necessary, even supposing the forms the most convenient, to lay aside the constants they contain, and to derive them anew from the more recent data.

There are two qualities required in a formula of this kind, accuracy and simplicity. The first is obtainable by such a form of equation as that suggested by Laplace, which expresses the expansive force by a series arranged according to the ascending powers of the temperature. This suggestion was afterwards modified by Biot, whose form has been adopted, in the main, by M. Regnault, as the basis of his principal and most approved and exact formulæ. The general form given by M. Regnault is the following:

$$\text{Log. } F = a A^{\theta} + b B^{\theta} + c C^{\theta} +$$

in which θ is a function of the thermometrical temperature, *t*; the other literal quantities are constants, to be determined from the series of experiments which the formula is intended to represent.

Egen's formula is likewise susceptible of accuracy. It is, in some measure, the inverse of that of Biot, and expresses the temperature by a series arranged according to the ascending powers of the logarithms of the elasticity.

Formulæ, according to these models, may include any number of points of the curve of pressures, and may therefore be made to express any required degree of exactness. But such formulæ become exceedingly unwieldy and inconvenient for the ordinary purposes of calculation, and they moreover do not admit of direct inversion. Thus we cannot, with M. Biot's equation, directly determine the temperature when the pres-

* But the merchant requires it—therefore it would seem that there ought to be two systems—a scientific and a commercial one.—[Ed. P. M. Journal.]

sure of the steam is given, and which is the calculation most commonly required; and, on the contrary, the pressure being sought, we cannot, with Egen's formula, directly represent it, in terms of the temperature and numerical constants.

The formula of Dr. Thomas Young, on which that of Creighton, Southern, Tredgold, Mellet, Coriolis, the Commission of the French Academy, the Committee of the Franklin Institute, Spasky, Combes, and Alexander, are founded, is comparatively simple in form, but does not admit of very great exactness over any considerable extent of the curve. The expression, in its most general form, is—

$$F = (a + b\,t)^m,$$

and for some purposes of investigation is very convenient in the form

$$\text{Log. F.} = m\,[\log.\,(t + a) - b\,].$$

This equation passes the curve through three given points, and when these are taken at no great distances apart, it may be employed to interpolate; but cannot with safety be extended to any considerable distance beyond the assumed limits.

Another class of formulæ is founded on that proposed by Professor Roche in 1828, from theoretical considerations. It expresses the elasticity by a constant number multiplied by a second constant, raised to a power of which the exponent is a fraction, having the temperature in the numerator, and some function of the temperature in the denominator. It is thus written—

$$F = a\,A^{\frac{t}{\gamma + t}}.$$

This form of expression has been virtually adopted by August and Strehlke, Von Wrede, Magnus, Holtzmann, and Shortrede, although differently derived; and although it ought not to be received as an absolute expression of the law, which it was originally intended to represent, as a formula of interpolation it is greatly superior to that of Dr. Young in extent and accuracy, and to that of Biot in point of simplicity. It approaches much more nearly to the required double condition than any other expression which has yet been proposed, and, in fact, as a practical formula applicable to calculations relative to the steam-engine, leaves little to be regretted that it is not absolute.

The most simple, and therefore the most convenient form to which this expression is reducible, is for the elastic force,

$$\text{Log. F} = A - \frac{B}{t + C},$$

and the inverse formula for finding the temperature when the pressure is given, is accordingly

$$t = \frac{B}{A - \log.\,F} - C.$$

A number of very careful determinations of the constants of this equation, from the graphic curve of pressures constructed by M. Regnault to represent the mean results of his experiments, have led me to conclude that no three points of that curve, which can be taken as data for the values of the constants, render the expression satisfactory throughout the entire range, experimentally represented. That range, however, extends over a space of 262° of the centigrade scale, equal to 471·6° of Fahrenheit's thermometer; namely, from 25·6° below the zero of Fahrenheit, at which the pressure is less than 0·006 lbs. on the square inch of surface, to 446° Fah., at which the pressure is over 400 lbs. on the same unit of area. Both extremes of this range are at present much beyond the limits at which a practical formula is required for calculations relating to the steam-engine. The lower limit, especially, is obviously of no moment, either at present or prospectively, for such an object, however important it may be for other scientific purposes—the calculation of refractions and other meteorological inquiries. I have accordingly taken 120° Fah. as the lower limit of temperature at which it is practically necessary to consider the elasticity of steam as a motive power, and have determined the constants from that limit to the higher extremity of the given curve, both for the air and mercurial thermometer. The values are arranged in the following table:—

When the elasticity of the steam is expressed in atmospheres of 29·9212 inches of mercury = 14·68728 lbs. on the square inch of surface,	then	A = 5·0321128 for the air thermometer = 4·8984483 for the mercurial do
When the elasticity is expressed in atmospheres of 30 inches of mercury, = 14·726 lbs. on the square inch,	then	A = 5·0312707 for the air thermometer. = 4·8977061 for the mercurial do.
When the elasticity is expressed in inches of mercury of sp. gr. 13·59596, which corresponds to the density at 32° Fah.,	then	A = 6·5083919 for the air thermometer. = 6·3748274 for the mercurial do.
When the elasticity is expressed in lbs. on the square inch,	then	A = 6·1993544 for the air thermometer. = 6·0657899 for the mercurial do.

For the air thermometer,.....	B = 2938·16	Log. B = 3·4680754
For the mercurial thermometer,	B = 2795·97	Log. B = 3·4465323
For the air thermometer,.....	C = 371·85	Log. C = 2·5703644
For the mercurial thermometer,	C = 358·74	Log. C = 2·5547798

The formulæ for P lbs. on the square inch, by the two modes of measuring the temperature, are therefore—

For the air thermometer,

$$\text{Log. P} = 6{\cdot}1993544 - \frac{2938{\cdot}16}{t + 371{\cdot}85}$$

$$t = \frac{2938{\cdot}16}{6{\cdot}1993544 - \log.\,P} - 371{\cdot}85$$

For the mercurial do. ...

$$\text{Log P.} = 6{\cdot}0657899 - \frac{2795{\cdot}97}{t + 358{\cdot}74}$$

$$t = \frac{2795{\cdot}97}{6{\cdot}0657899 - \log.\,P} - 358{\cdot}74$$

The following table exhibits a comparison between the results of these formulæ and the corresponding points of M. Regnault's curve. The difference is marked + when the result by the formula exceeds the given pressure, and — when the given pressure is the greater:—

Table of the pressure of saturated steam for every eighteen degrees of temperature by Fahrenheit's scale, from 122° upwards, corresponding to the points of the curves of pressure tabulated by M. Regnault, for successive steps of ten degrees of temperature, according to the Centigrade scale:—

By the Air Thermometer, Log. $P = 6{\cdot}1993544 - \frac{2938{\cdot}16}{t + 371{\cdot}847}$							By the Mercurial Thermometer, Log. $P = 6{\cdot}0657899 - \frac{2795{\cdot}97}{t + 358{\cdot}74}$					
Temperatures corresponding to the given points,		Pressure of the Steam in lbs. on the square inch,		Differences.	Common Logarithms of the Pressures by the		Pressure of the Steam in lbs. on the square inch,		Differences.	Common Logarithms of the Pressures by the		Temperatures corresponding to the given points
By the Centigrade Scale.	By Fahrenheit's Scale.	By M. Regnault's Curve.	By the Formula.		Given Curve.	Formula.	By M. Regnault's Curve.	By the Formula.		Given Curve.	Formula.	By the Centigrade Scale.	By Fahrenheit's Scale.
50	122	1·777548	1·777548	+·000000	0·2498214	0·2498215		1·77755	+·00000		0·2498219	50	122
60	140	2·875422	2·877710	+·002285	0·4587017	0·4590465		2·88221	+·00679		0·4597259	60	140
70	158	4·50455	4·50873	+·00418	0·6536516	0·6540544		4·51866	+·01411		0·6550098	70	158
80	176	6·85355	6·85886	+·00531	0·8359157	0·8362520		6·8729	+·0193		0·8371399	80	176
90	194	10·15452	10·15908	+·00452	1·0066594	1·0068544		10·1721	+·0176		1·0074109	90	194
100	212	14·68728	14·68728	·00000	1·1669416	1·1669416		14·6873	·0009		1·1669416	100	212
110	230	20·7497	20·7707	+·0210	1·3170110	1·3174500	20·7361	20·7357	—·0005	1·3167277	1·3167179	110	230
120	248	28·7755	28·7885	+·0130	1·4590227	1·4592190	28·6595	28·6819	+·0224	1·4572692	1·4576079	120	248
130	266	39·2112	39·1729	—·0383	1·5934100	1·5929855	38·9468	38·9385	—·0083	1·5899718	1·5703788	130	266
140	284	52·4297	52·4093	—·0204	1·7195778	1·7194082	51·8307	51·9652	+·1345	1·7145868	1·7157129	140	284
150	302	69·0303	69·0361	+·0051	1·8390395	1·8390784	68·2572	68·2681	+·0109	1·8341487	1·8342179	150	302
160	320	89·7950	89·6453	—·1497	1·9533007	1·9525277	88·5102	88·3971	—·1131	1·9469935	1·9464379	160	320
170	338	115·1793	114·8708	—·3085	2·0613743	2·0602096	112·899	112·943	+·044	2·0526896	2·0528599	170	338
180	356	145·8100	145·4027	—·4073	2·1637872	2·1625726	142·351	142·535	+·184	2·1533597	2·1539229	180	356
190	374	182·1997	181·9681	—·2316	2·2605476	2·2599953	177·871	177·835	—·0357	2·2501046	2·2500179	190	374
200	392	225·3340	225·3330	—·0010	2·3528263	2·3528252	219·531	219·537	+·006	2·3415063	2·3415073	200	392
210	410	276·5075	276·2955	—·2120	2·4417069	2·4413738	268·526	268·356	—·170	2·4289866	2·4287107	210	410
220	428	336·0690	335·7001	—·3689	2·5264276	2·5259515	325·111	325·030	—·081	2·5120314	2·5119233	220	428
230	446	404·1927	404·3906	+·1979	2·6065859	2·6068011	389·5995	390·315	+·7345	2·5906185	2·5914148	230	446

In comparing the results contained in this table, it must be considered that it involves the double uncertainty arising from the observation of the pressures and the temperatures during the experiments. The probable error of the pressure may be reckoned at a minimum = 0·002 lb. on the unit of surface; and the uncertainty of the thermometrical observations can hardly be less than $\frac{1}{15}$ of a degree of Fahrenheit, even at low temperatures, and at high temperatures it considerably exceeds that fraction. These two sorts of uncertainty combined, are sufficient to account for most, if not all, the differences found in the table. Thus, in the table for the air thermometer, the greatest difference is 0·4073 lb. at 356° Fah.; now, supposing this difference to be entirely attributable to error of observation of the temperature alone, it would not amount to $\frac{2}{100}$ of a degree of Fahrenheit's scale. The alternation of the signs prefixed to the differences, also indicate that those differences are, at least in part, due to errors of observation. This is especially observable in the column of differences in the table for the mercurial thermometer.

These circumstances being taken into consideration, in connection with the very small values of the differences exhibited in the table, lead to the conclusion, that the formulæ may be received with confidence within the limits for which they are given. For pressures below that of the atmosphere, the formula for the air thermometer, it will be observed, is more satisfactory than that for the mercurial thermometer; whereas the converse is observable at higher pressures, with the exception of the extreme ordinate.

The formula for pressures lower than those given in the table becomes

$$\text{Log. } h = 7{\cdot}0731112 - \frac{3522{\cdot}015}{t + 418{\cdot}663},$$

when the elasticity, h, is expressed in inches of mercury. This formula does not, however, extend satisfactorily much below the freezing temperature, 32° Fah. I have indeed failed in repeated attempts to include the curve on both sides of that point in a formula of this form: at that point the character of the curve seems to change, and to include some new element: possibly the crystallizing force may there come into action. A comparison of the results given by this formula, with those given by M. Regnault's curve, is contained in the following table:—

Temperature.		Pressure of Vapour in inches of Mercury		Differences.	Logarithms of the Pressures	
Centigrade.	Fahrenheit.	By Given Curve.	By the Formula.		By the Given Curve.	By the Formula.
0	32	0·181102	0·181102	·00000	1·2579233	
10	50	0·360621	0·36148	+ ·00086	1·5570610	1·55808
20	68	0·68464	0·68552	+ ·00088	1·8354651	1·83602
30	86	1·24212	1·24212	·0000	0·0941649	
40	104	2·16181	2·1603	— ·0015	0·3348169	0·33451
50	122	3·62125	3·62125	·0000	0·5588589	

The curve between the temperature of 212° and 32° is very satisfactorily represented by the equation,

$$\text{Log. P} = \text{A} - \frac{3225{\cdot}4}{t + 397{\cdot}4},$$

in which A = 6·7687264, when P represents inches of mercury,
= 6·4597889, „ P „ lbs. on the square inch.

Except, however, for the low pressures, to which the preceding formula still better applies, this last is not preferable to the general formula for the air thermometer—which, indeed, may be used down to 32° when extreme accuracy is not required.

It may also here be observed, that the indications by the air thermometer are greatly more to be relied upon than those of the mercurial. The air thermometer is not only more sensitive, but likewise admits of the employment of a relatively larger volume of the expanding fluid, compared with the volume of the glass envelope in which it is enclosed. The errors arising from the different expansibilities of different qualities of glass are, in consequence, much reduced relatively in amount; and besides, the expansion of the fluid is *very nearly uniform* for equal increments of temperature. It is, however, the mercurial thermometer which is ordinarily employed in the measurement of temperatures, and accordingly it is of importance that the indications of the ordinary instrument should be represented by an appropriate formula. This formula, it is true, cannot possess more than an average approximation to the measurements by any particular instrument; for all thermometers made from different qualities of glass, even when the usual fixed points are exactly and accurately determined, differ from one another at the higher temperatures. This is fully illustrated by the comparisons given by M. Regnault, in his memoir on the measurement of temperature, which has been justly characterized as one of the most elegant and successful examples we possess of the combination of experimental adaptation with inductive application of the results obtained. Let us take a single line of one of the many tables furnished: it compares four of the mercurial thermometers used with each other, and with the temperature indicated by the standard air thermometer. Take the temperature of 250° C. by the standard: in the medium, having that temperature, the mercurial thermometer of

Choisy-le-Roi crystal indicated.....253°·00 C.
Ordinary glass.....250 ·05
Green glass.....251 ·85
Swedish glass.....251 ·44

At 100 degrees higher, namely, 350° C. by the air thermometer, the first of these four thermometers gave 360·5°, and the second 354°, as the temperature of the same medium. In this it is to be remarked, that the deviations of the ordinary glass thermometer are the least; and this is true throughout the whole extent of the table—a circumstance which ought to attract the attention, especially of the makers of those instruments.

The wide differences thus shown to exist among thermometrical instruments of the very best description, render it little surprising that there should have existed very considerable discrepancies among the results obtained by different experimenters, in investigations involving the measurement of temperatures. Both Regnault and Magnus have fortunately avoided this source of uncertainty in their researches relative to the elasticity of gaseous fluids, and, accordingly, their results agree with remarkable nearness.

W. M. Buchanan.

SIR DAVID BREWSTER'S ADDRESS TO THE BRITISH ASSOCIATION.

TWENTIETH MEETING, EDINBURGH, July 30, 1850.

The kind and flattering expressions with which Dr. Robinson has been pleased to introduce me to this chair, and to characterise my scientific labours, however coloured they are by the warmth of friendship, cannot but be gratifying even at a time when praise ceases to administer to vanity or to stimulate ambition. The appreciation of intellectual labour by those who have laboured intellectually, if not its highest, is at least one of its high rewards. When I consider the mental power of my distinguished friend, the value of his original researches, the vast extent of his acquirements, and the eloquence which has so often instructed and delighted us at our annual reunions, I feel how unfit I am to occupy his place, and how little I am qualified to discharge many of those duties which are incident to the chair of this Association. It is some satisfaction, however, that you are all aware of the extent of my incapacity, and that you have been pleased to accept of that which I can both promise and perform—to occupy any post of labour, either at the impelling or the working arm of this gigantic lever of science. On the return of the British Association to the metropolis of Scotland, I am naturally reminded of the small band of pilgrims who, in 1831, carried the seeds of this institution into the more genial soil of our sister land—of the zeal and talent with which it was fostered and organized by the Philosophical Society of York—of the hospitality which it enjoyed from the Primate of England—of the invaluable aid which it received from the universities and scientific societies of the south—and of the ardent support with which it was honoured by some of the most accomplished of our nobility. From its cradle at York, the infant Association was ushered into the gorgeous halls of Oxford and Cambridge—the seats of ancient wisdom, and the foci of modern science. University honours were liberally extended to its more active members, and, thus decorated, our institution was eagerly welcomed into the rich marts of our commerce, and into the active localities of our manufacturing industry. Europe and America speedily recognized the importance of our rising Association, and deputies from every civilized nation hastened to our annual congress, assisted at our sectional meetings, and have even contributed to our Transactions valuable reports on different branches of science. It may be interesting to those who are here for the first time, to learn the names of some of those distinguished individuals by whose exertions and talents this Association has attained its present magnitude and position; and I feel as if it were peculiarly my duty to do honour to their zeal and their labours. Sir John Robison, Professor Johnston, and Professor Forbes, were the earliest friends and promoters of the British Association. They went to York to assist in its establishment, and they found there the very men who were qualified to foster and organize it. The Rev. Vernon Harcourt, whose name cannot be mentioned here without the expression of

our admiration and gratitude, had provided laws for its government, and along with Mr. Phillips, the oldest and most valuable of our office-bearers, had made all those arrangements by which its success was insured. Dalton, Pritchard, Greenough, Scoresby, William Smith, Sir Thomas Brisbane, Dr. Daubeny, Professor Potter, Lord Fitzwilliam, and Lord Morpeth, assisted at its inauguration; and so great was the interest excited by its proceedings, that Dr. Daubeny ventured to invite the Association to hold its second meeting at Oxford. Here it received the valuable co-operation of Dr. Buckland, Professor Powell, and the other distinguished men who adorn that seat of literature and science. Cambridge sent us her constellation of philosophers—bright with stars of the first magnitude—Whewell, Peacock, Sedgwick, Airy, Herschel, Babbage, Lubbock, Challis, Kelland, and Hopkins; while the metropolitan institutions were represented by Sir Roderick Murchison and Colonel Sabine, our two General Secretaries; Mr. Taylor, our Treasurer; Sir Charles Lyell, Colonel Sykes, Mr. Brown, Mr. Faraday, Professors Owen and Wheatstone, Dr. Mantell, Lord Northampton, Lord Wrottesley, Sir Philip Egerton, and Sir Charles Lemon. From Ireland we received the distinguished aid of Lord Rosse, Lord Enniskillen, Lord Adare, Dr. Robinson, Dr. Lloyd, Sir William Hamilton, and Professor Maccullagh; and men of immortal names were attracted from the continents of Europe and America—Arago, Bessel, Struve, Liebig, Jacobi, Le Verrier, Encke, Erman, Kupffer, Ehrenberg, Matteucci, Rogers, Bache, and Agassiz. The younger members of the Association, to whom we owe much, and from whom we expect more, will excuse me for not making an individual reference to their labours. Their day of honour will come when our brief pilgrimage has closed. We bequeath to them a matured institution, and we trust that they will leave it to a succeeding race with all the life which it now breathes, and with all the glory which now surrounds it. It has been the custom of some of my predecessors in this chair to give a brief account of the progress of the sciences during the preceding year; but however interesting such a narrative might be, it would be beyond the power of any individual to do justice to so extensive a theme, even if your time would permit, and your patience endure it. I shall make no apology, however, for calling your attention to a few of those topics, within my own narrow sphere of study, which, from their prominence and general interest, may be entitled to your attention. I begin with astronomy, a study which has made great progress under the patronage of this Association—a subject, too, possessing a charm above all other subjects, and more connected than any with the deepest interests, past, present, and to come, of every rational being. It is upon a planet that we live and breathe. Its surface is the arena of our contentions, our pleasures, and our sorrows. It is to obtain a portion of its alluvial crust that man wastes the flower of his days, and prostrates the energies of his mind, and risks the happiness of his soul; and it is over or beneath its verdant turf that his ashes are to be scattered, or his bones to be laid. It is from the interior, too—from the inner life of the earth, that man derives the materials of civilization—his coal, his iron, and his gold. And deeper still, as geologists have proved—and none with more power than the geologists around me—we find in the bosom of the earth, written on blocks of marble, the history of primeval times—of worlds of life created, and worlds of life destroyed. We find there—in hieroglyphics as intelligible as those which Major Rawlinson has deciphered on the slabs of Nineveh—the remains of forests which waved in luxuriance over its plains; the very bones of huge reptiles that took shelter under their foliage, and of gigantic quadrupeds that trod uncontrolled its plains—the lawgivers and the executioners of that mysterious community with which it pleased the Almighty to people His infant world. But though man is but a recent occupant of the earth—an upstart in the vast chronology of animal life, his interest in the paradise so carefully prepared for him is not the less exciting and profound. For him it was made; he was to be the lord of the new creation, and to him it especially belongs to investigate the wonders it displays, and to learn the lesson which it reads. But while our interests are thus closely connected with the surface and the interior of the earth, interests of a higher kind are associated with it as a body of the solar system to which we belong. The object of geology is to unfold the history and explain the structure of a planet; and that history and that structure may, within certain limits, be the history and the structure of all the other planets of the system—perhaps of all the other planets of the universe. The laws of matter must be the same, wherever matter is found. The heat which warms our globe radiates upon the most distant of the planets; and the light which twinkles in the remotest star is, in its physical, and doubtless in its chemical properties, the same that cheers and enlivens our own system; and if men of ordinary capacity possessed that knowledge which is within their reach, and had that faith in science which its truths inspire, they would see in every planet around them, and in every star above them, the home of immortal natures—of beings that suffer, and of beings that rejoice—of souls that are saved, and of souls that are lost. Geology is, therefore, the first chapter of astronomy. It describes that portion of the solar system which is nearest and dearest to us—the cosmopolitan observatory, so to speak, from which the astronomer is to survey the sidereal universe, where revolving worlds, and systems of worlds, summon him to investigate and adore. There, too, he obtains the great base lines of the earth's radius to measure the distances and magnitudes of the starry host, and thus to penetrate, by the force of *reason*, into those infinitely distant regions where the imagination dare not follow him. But astronomy, though thus sprung from the earth, seeks and finds, like Astræa, a more congenial sphere above. Whatever cheers and enlivens our terrestrial paradise, is derived from the orbs around us. Without the light or heat of our sun, and without the uniform movements of our system, we should have neither climates nor seasons. Darkness would blind, and famine destroy, everything that lives. Without influences from above, our ships would drift upon the ocean, the sport of wind and wave, and would have less security of reaching their destination than balloons floating in the air, and subject to the caprice of the elements. But while the study of astronomy is essential to the very existence of social life, it is instinct with moral influences of the highest order. In the study of our own globe, we learn that it has been rent and upheaved by tremendous forces—here sinking into ocean depths, and there rising into gigantic elevations. Even now geologists are measuring the rise and fall of its elastic crust; and men who have no faith in science often learn the truth to their cost, when they see the liquid fire rushing upon them from the volcano, or stand above the yawning crevice in which the earthquake threatens to overwhelm them. Who can say that there is a limit to agencies like these? Who could dare to assert that they may not concentrate their yet divided energies, and rend in pieces the planet which imprisons them? Within the bounds of our own system, and in the vicinity of our own earth, between the orbits of Mars and Jupiter, there is a wide space which, according to the law of planetary distance, ought to contain a planet. Kepler predicted that a planet would be found there—and, strange to say, the astronomers of our own times discovered at the beginning of the present century four small planets, Ceres, Pallas, Juno, and Vesta, occupying the very place in our system where the anticipated planet ought to have been found. Ceres, the first of these, was discovered by Piazzi, at Palermo, in 1801; Pallas, the second of them, by Dr. Olbers, of Bremen, in 1802; Juno, the third, by Mr. Harding, in 1804; and Vesta, the fourth, by Dr. Olbers, in 1807. After the discovery of the third, Dr. Olbers suggested the idea that they were the fragments of a planet that had been burst in pieces; and, considering that they must all have diverged from one point in the original orbit, and ought to return to the opposite point, he examined these parts of the heavens, and thus discovered the planet Vesta. But though this principle was in the possession of astronomers, nearly forty years elapsed before any other planetary fragment was discovered. At last, in 1845, Mr. Encke, of Driessen, in Prussia, discovered the fragment called Astræa, and in 1847 another, called Hebe. In the same year, our countryman, Mr. Hind, discovered other two, Iris and Flora. In 1848, Mr. Graham, an Irish astronomer, discovered a ninth fragment, called Metis. In 1849, Mr. Gasparis, of Naples, discovered another, which he calls Hygeia; and within the last two months, the same astronomer has discovered the eleventh fragment, to which he has given the name of Parthenope.* If these eleven small planets are really the remains of a larger one, the size of the original planet must have been considerable. What its size was, would seem to be a problem beyond the grasp of reason. But human genius has been permitted to triumph over greater difficulties. The planet Neptune was discovered before a ray of its light had entered the human eye; and by a law of the solar system, just discovered, we can determine the original magnitude of the broken planet long after it has been shivered into fragments; and we might have determined it even after a single fragment had proved its existence. This law we owe to Mr. Daniel Kirkwood, of Pottsville, a humble American, who, like the illustrious Kepler, struggled to find something new among the arithmetical relations of the planetary elements. Between every two adjacent planets there is a point where their attractions are equal. If we call the distance of this point from

* Ceres,.....1801, January 1st,.....Piazzi.
Pallas,.....1802, March 28th,.....Olbers.
Juno,.....1804, September 1st,.....Harding.
Vesta,.....1807, March 29th,.....Olbers.
Astræa,.....1845, December 8th,.....Encke.
Hebe,.....1847, July 1st,.....Encke.
Iris,.....1847, August 13th,.....Hind.
Flora,.....1847, October 18th,.....Hind.
Metis,.....1848, April 25th,.....Graham.
Hygeia,.....1849, April 12th,.....Gasparis.
Parthenope,.....1850, May 11th,.....Gasparis

the sun the radius of a planet's sphere of attraction, then Mr. Kirkwood's law is, that in every planet the square of the length of its year, reckoned in days, varies as the cube of the radius of its sphere of attraction. This law has been verified by more than one American astronomer, and there can be no doubt, as one of them expresses it, that it is at least a physical fact in the mechanism of our system. This law requires the existence of a planet between Mars and Jupiter, and it follows, from the law, that the broken planet must have been a little larger than Mars, or about 5,000 miles in diameter, and that the length of its day must have been about 57½ hours. The American astronomers regard this law as amounting to a demonstration of the nebular hypothesis of Laplace; but we venture to say that this opinion will not be adopted by the astronomers of England. Among the more recent discoveries within the bounds of our own system, I cannot omit to mention those of our distinguished countryman, Mr. Lassell of Liverpool. By means of a fine twenty-feet reflector, constructed by himself, he detected the satellite of Neptune, and more recently an eighth satellite circulating round Saturn—a discovery which was made on the very same day by Mr. Bond, Director of the Observatory of Cambridge, in the United States. Mr. Lassell has still more recently, and under a singularly favourable state of the atmosphere, observed the very minute, but extremely black, shadow of the ring of Saturn upon the body of the planet. He observed the line of shadow to be notched, as it were, and almost broken up into a line of dots—thus indicating mountains upon the plane of the ring—mountains, doubtless, raised by the same internal forces, and answering the same ends, as those of our own globe. In passing from our solar system to the frontier of the sidereal universe around us, we traverse a gulf of inconceivable extent. If we represent the radius of the solar system, or of Neptune's orbit (which is 2,900 millions of miles), by a line two miles long, the interval between our system, or the orbit of Neptune, and the nearest fixed star, will be greater than the whole circumference of our globe—or equal to a length of 27,600 miles. The parallax of the nearest fixed star being supposed to be one second, its distance from the sun will be nearly 412,370 times the radius of the earth's orbit, or 13,746 times that of Neptune, which is thirty times as far from the sun as the earth. And yet to that distant zone has the genius of man traced the Creator's arm working the wonders of his power, and diffusing the gifts of his love —the heat and the light of suns—the necessary elements of physical and intellectual life. It is by means of the gigantic telescope of Lord Rosse that we have become acquainted with the form and character of those great assemblages of stars which compose the sidereal universe. Drawings and descriptions of the more remarkable of these nebulæ, as resolved by this noble instrument, were communicated by Dr. Robinson to the last meeting of the Association, and it is with peculiar satisfaction that I am able to state that many important discoveries have been made by Lord Rosse and his assistant, Mr. Stoney, during the last year. In many of the nebulæ the peculiarities of structure are very remarkable, and, as Lord Rosse observes, 'seem even to indicate the presence of dynamical laws almost within our grasp.' The spiral arrangement so strongly developed in some of the nebulæ is traceable more or less distinctly in many; but 'more frequently,' to use Lord Rosse's own words, 'there is a nearer approach to a kind of irregular, interrupted, annular disposition of the luminous material, than to the irregularity observed in others;' but his Lordship is of opinion that those nebulæ are systems of a very similar nature, seen more or less perfectly, and variously placed with reference to the line of sight. In re-examining the more remarkable of these objects, Lord Rosse intends to view them with the full light of his six-feet speculum, undiminished by the second reflection of the small mirror. By thus adopting what is called the *front view*, he will doubtless, as he himself expects, discover many new features in those interesting objects. It is to the influence of Lord Rosse's example that we are indebted for the fine reflecting telescope of Mr. Lassell, of which I have already spoken; and it is to it, also, that we owe another telescope, which, though yet unknown to science, I am bound in this place especially to notice. I allude to the reflector recently constructed by Mr. James Nasmyth, a native of this city, already distinguished by his mechanical inventions, and one of a family well known to us all, and occupying a high place among the artists of Scotland. This instrument has its great speculum 20 feet in focal length, and 20 inches in diameter; but it differs from all other telescopes in the remarkable facility with which it can be used. Its tube moves vertically upon hollow trunnions, through which the astronomer, seated in a little observatory, with only a horizontal motion, can view at his ease every part of the heavens. Hitherto the astronomer has been obliged to seat himself at the upper end of his Newtonian telescope; and if no other observer will acknowledge the awkwardness and insecurity of his position, I can myself vouch for its danger, having fallen from the very top of Mr. Ramage's twenty-feet telescope, when it was directed to a point not very far from the zenith. Though but slightly connected with astronomy, I cannot omit calling your attention to the great improvements—I may call them discoveries—which have been recently made in Photography. I need not inform this meeting that the art of taking photographic *negative* pictures upon paper was the invention of Mr. Fox Talbot, a distinguished member of this Association. The superiority of the Talbotype to the Daguerreotype is well known. In the latter the pictures are reverted, and incapable of being multiplied, while in the Talbotype there is no reversion, and a single negative will supply a thousand copies, so that books may now be illustrated with pictures drawn by the sun. The difficulty of procuring good paper for the negative is so great, that a better material has been eagerly sought for; and M. Niepce, an accomplished officer in the French service, has successfully substituted for paper a film of albumen, or the white of an egg, spread upon glass. This new process has been brought to such perfection in this city by Messrs. Ross and Thompson, that Talbotypes taken by them, and lately exhibited by myself to the National Institute of France, and to M. Niepce, were universally regarded as the finest that had yet been executed. Another process, in which gelatine is substituted for albumen, has been invented, and successfully practised, by M. Poitevin, a French officer of engineers; and by an ingenious method, which has been minutely described in the weekly proceedings of the Institute of France, M. E. Becquerel has succeeded in transferring to a Daguerreotype plate the prismatic spectrum, with all its brilliant colour, and also, though in an inferior degree, the colours of the landscape. These colours, however, are very fugaceous: yet, though no method of fixing them has yet been discovered, we cannot doubt that the difficulty will be surmounted, and that we shall yet see all the colours of the natural world transferred by their own rays to surfaces both of silver and paper. But the most important fact in photography which I have now to mention, is the singular acceleration of the process discovered by M. Niepce, which enables him to take the picture of a landscape, illuminated by diffused light, in a single second, or at most in two seconds. By this process he obtained a picture of the sun on albumen so instantaneously, as to confirm the remarkable discovery, previously made by M. Arago by means of a silver plate, that the rays which proceed from the central parts of the sun's disc, have a higher photogenic action than those which issue from its margin. This interesting discovery of M. Arago is one of a series on photometry, which that distinguished philosopher is now occupied in publishing. Threatened with a calamity which the civilized world will deplore—the loss of that sight which has detected so many brilliant phenomena, and penetrated so deeply the mysteries of the material world, he is now completing, with the aid of other eyes than his own, those splendid researches which will immortalize his own name, and add to the scientific glory of his country.

LAW OF COPYRIGHT OF DESIGNS AMENDMENT ACT.

[One of the latest fruits of the past session is this Act. From the late period at which it has been received, we are not able to do more than to give the Act, and let it speak for itself. We hope, in our next number, to have something to say as to its practical effect.—Ed. P. M. Journal.]

AN ACT TO EXTEND AND AMEND THE ACTS RELATING TO THE COPYRIGHT OF DESIGNS.

Whereas it is expedient to extend and amend the Acts relating to the Copyrights of Designs: Be it therefore enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same:

I. That the registrar of designs, upon application by or on behalf of the proprietor of any design not previously published within the United Kingdom of Great Britain and Ireland or elsewhere, and which may be registered under the Designs Act, 1842, or under the Designs Act, 1843, for the provisional registration of such design under this Act, and upon being furnished with such copy, drawing, print, or description, in writing or in print, as in the judgment of the said registrar shall be sufficient to identify the particular design in respect of which such registration is desired, and the name of the person claiming to be proprietor, together with his place of abode or business, or other place of address, or the style or title of the firm under which he may be trading, shall register such design in such manner and form as shall from time to time be prescribed or approved by the Board of Trade; and any design so registered shall be deemed "provisionally registered," and the registration thereof shall continue in force for the term of one year from the time of the same being registered as aforesaid; and the said registrar shall certify, under his hand and seal of office, in such form as the said Board shall direct or approve, that the design has been provisionally registered, the date of

such registration, and the name of the registered proprietor, together with his place of abode or business, or other place of address.

II. That the proprietor of any design which shall have been provisionally registered shall, during the continuance of such registration, have the sole right and property in such design; and the penalties and provisions of the said Designs Act, 1842, for preventing the piracy of designs, shall extend to the acts, matters, and things next hereinafter enumerated, as fully as if those penalties and provisions had been re-enacted in this Act, and expressly extended to such acts, matters, and things respectively; that is to say:

1. To the application of any provisionally registered design, or any fraudulent imitation thereof, to any article of manufacture or to any substance.
2. To the publication, sale, or exposure for sale of any article of manufacture, or any substance to which any provisionally registered design shall have been applied.

III. That during the continuance of such provisional registration, neither such registration nor the exhibition or exposure of any design provisionally registered, or of any article to which any such design may have been or be intended to be applied in any place, whether public or private, in which articles are not sold or exposed or exhibited for sale, and to which the public are not admitted gratuitously, or in any place which shall have been previously certified by the Board of Trade to be a place of public exhibition within the meaning of this Act, nor the publication of any account or description of any provisionally registered design exhibited or exposed, or intended to be exhibited or exposed, in any such place of exhibition, or exposure in any catalogue, paper, newspaper, periodical, or otherwise, shall prevent the proprietor thereof from registering any such design under the said Designs Acts at any time during the continuance of the provisional registration, in the same manner and as fully and effectually is if no such registration, exhibition, exposure, or publication had been made; provided that every article to which any such design shall be applied, and which shall be exhibited or exposed, by or with the license or consent of the proprietor of such design, shall have thereon or attached thereto the words "provisionally registered," with the date of registration.

IV. That if during the continuance of such provisional registration the proprietor of any design provisionally registered shall sell, expose, or offer for sale any article, substance, or thing to which any such design has been applied, such provisional registration shall be deemed to have been null and void immediately before any such sale, offer, or exposure shall have been first made; but nothing herein contained shall be construed to hinder or prevent such proprietor from selling or transferring the right and property in any such design.

V. That the Board of Trade may, by order in writing, with respect to any particular class of designs, or any particular design, extend the period for which any design may be provisionally registered under this Act for such term not exceeding the additional term of six months, as to the said Board may seem fit; and whenever any such order shall be made, the same shall be registered in the office for the registration of designs; and during the extended term the protection and benefits conferred by this Act, in case of provisional registration, shall continue as fully as if the original term of one year had not expired.

VI. That the registrar of designs, upon application by or on behalf of the proprietor of any sculpture, model, copy, or cast, within the protection of the Sculpture Copyright Acts, and upon being furnished with such copy, drawing, print, or description in writing or in print, as in the judgment of the said registrar shall be sufficient to identify the particular sculpture, model, copy, or cast, in respect of which registration is desired, and the name of the person claiming to be proprietor, together with his place of abode or business, or other place of address, or the name, style, or title of the firm under which he may be trading, shall register such sculpture, model, copy, or cast, in such manner and form as shall from time to time be prescribed or approved by the Board of Trade, for the whole or any part of the term during which copyright in such sculpture, model, copy, or cast, may or shall exist under the Sculpture Copyright Acts; and whenever any such registration shall be made, the said registrar shall certify under his hand and seal of office, in such form as the said Board shall direct or approve, the fact of such registration, and the date of the same, and the name of the registered proprietor, or the style or title of the firm under which such proprietor may be trading, together with his place of abode or business, or other place of address.

VII. That if any person shall, during the continuance of the copyright in any sculpture, model, copy, or cast, which shall have been so registered as aforesaid, make, import, or cause to be made, imported, exposed for sale, or otherwise disposed of, any pirated copy or pirated cast of any such sculpture, model, copy, or cast, in such manner and under such circumstances as would entitle the proprietor to a special action on the case under the Sculpture Copyright Acts, the person so offending shall forfeit for every such offence a sum not less than five pounds and not exceeding thirty pounds to the proprietor of the sculpture, model, copy, or cast, whereof the copyright shall have been infringed; and for the recovery of any such penalty the proprietor of the sculpture, model, copy, or cast, which shall have been so pirated, shall have and be entitled to the same remedies as are provided for the recovery of penalties incurred under the Designs Act, 1842: Provided always, that the proprietor of any sculpture, model, copy, or cast, which shall be registered under this Act, shall not be entitled to the benefit of this Act, unless every copy or cast of such sculpture, model, copy, or cast, which shall be published by him after such registration, shall be marked with the word "registered," and with the date of registration.

VIII. That designs for the ornamenting of ivory, bone, papier-maché, and other solid substances not already comprised in the classes numbered 1, 2, or 3 in the Designs Act, 1842, shall be deemed and taken to be comprised within the class numbered 4 in that Act, and such designs shall be so registered accordingly.

IX. That the Board of Trade may from time to time order that the copyright of any class of designs or any particular design registered, or which may be registered under the Designs Act, 1842, may be extended for such term, not exceeding the additional term of three years, as the said Board may think fit, and the said Board shall have power to revoke or alter any such order as may from time to time appear necessary; and whenever any order shall be made by the said Board under this provision, the same shall be registered in the office for the registration of designs, and during the extended term the protection and benefits conferred by the said Designs Acts shall continue as fully as if the original term had not expired.

X. That the Board of Trade may from time to time make, alter, and revoke rules and regulations with respect to the mode of registration, and the documents and other matters and particulars to be furnished by persons effecting registration and provisional registration under the said Acts and this Act: Provided always, that all such rules and regulations shall be published in the "London Gazette," and shall forthwith upon the issuing thereof be laid before Parliament, if Parliament be sitting, and if Parliament be not sitting, then within fourteen days after the commencement of the then next session; and such rules and regulations, or any of them, shall be published or notified by the registrar of designs in such other manner as the Board of Trade shall think fit to direct.

XI. That if in any case in which the registration of a design is required to be made under either of the said Designs Acts, it shall appear to the registrar that copies, drawings, or prints as required by those Acts cannot be furnished, or that it is unreasonable or unnecessary to require the same, the said registrar may dispense with such copies, drawings, or prints, and may allow in lieu thereof such specification or description in writing or in print as may be sufficient to identify and render intelligible the design in respect of which registration is desired; and whenever registration shall be so made in the absence of such copies, drawings, or prints, the registration shall be as valid and effectual to all intents and purposes as if such copies, drawings, or prints had been furnished.

XII. That in order to prevent the frequent and unnecessary removal of the public books and documents in the office for the registration of designs, no book or document in the said office shall be removed for the purpose of being produced in any court, or before any justice of the peace, without a special order of a judge of the Court of Chancery, or of one of Her Majesty's superior Courts of Law, first had and obtained by the party who shall desire the production of the same.

XIII. That if application shall be made to a judge of any of Her Majesty's Courts of Law at Westminster, by any person desiring to obtain a copy of any registration, entry, drawing, print, or document, of which such person is not entitled as of right to have a copy for the purpose of being used in evidence in any cause, or otherwise howsoever, and if such judge shall be satisfied that such copy is *bonâ fide* intended for such purpose as aforesaid, such judge shall order the registrar of designs to deliver such copy to the party applying, and the registrar of designs shall, upon payment for the same of such fee or fees as may be fixed according to the provisions of the said Designs Acts in this behalf, deliver such copy accordingly.

XIV. That every copy of any registration, entry, drawing, print, or document, delivered by the registrar of designs to any person requiring the same, shall be signed by the said registrar, and sealed with his seal of office; and every document sealed with the said seal, purporting to be a copy of any registration, entry, drawing, print, or document, shall be deemed to be a true copy of such registration, entry, drawing, print, or document, and shall, without further proof, be received in evidence before all courts in like manner and to the same extent and effect as the original book, registration, entry, drawing, print, or document would or might

be received if tendered in evidence, as well for the purpose of proving the contents, purport, and effect of such book, registration, entry, drawing, print, or document, as also proving the same to be a book, registration, entry, drawing, print, or document of or belonging to the said office, and in the custody of the registrar of designs.

XV. That the several provisions contained in the said Designs Acts (so far as they are not repugnant to the provisions of this Act) relating to the transfer of designs, to cancelling and amending registration, to the refusal of registration in certain cases, to the mode of recovering penalties, to the awarding and recovery of costs, to actions for damages, to the limitation of actions, to the certificate of registration, to penalties for wrongfully using marks, to the fixing and application of fees for registration, and to the penalty for extortion, shall apply to the registration, provisional registration, and transfer of designs, sculptures, models, copies, and casts, and to the designs, sculptures, models, copies, and casts entitled to protection under this Act, and to matters under this Act, as fully and effectually as if those provisions had been re-enacted in this Act with respect to designs, sculptures, models, copies, and casts registered and provisionally registered under this Act; and the forms contained in the Designs Act, 1842, may for the purposes of this Act be varied so as to meet the circumstances of the case.

XVI. That in the interpretation of this Act the following terms and expressions shall have the meanings hereinafter assigned to them, unless such meanings shall be repugnant to or inconsistent with the context or subject matter; that is to say,

The expression "Designs Act, 1842," shall mean an Act passed in the sixth year of the reign of Her present Majesty, intituled "An Act to consolidate and amend the Laws relating to the Copyright of Designs for ornamenting Articles of Manufacture:"

The expression "Designs Act, 1843," shall mean an Act passed in the seventh year of Her present Majesty, intituled "An Act to amend the Laws relating to the Copyright of Designs:"

The expression "Sculpture Copyright Acts," shall mean two Acts passed respectively in the thirty-eighth and fifty-fourth years of the reign of King George the Third, and intituled respectively "An Act for encouraging the Art of making new Models and Casts of Busts and other Things herein mentioned," and "An Act to amend and render more effectual an Act for encouraging the Art of making new Models and Casts of Busts and other Things therein mentioned:"

The expression "The Board of Trade," shall mean the Lords of the Committee of Privy Council for the consideration of all matters of Trade and Plantations:

The expression "Registrar of Designs," shall mean the registrar or assistant-registrar of designs for articles of manufacture:

The expression "Proprietor," shall be construed according to the interpretation of that word in the said Designs Act, 1842:

And words in the singular number shall include the plural, and words applicable to males shall include females.

XVII. That in citing this Act in other Acts of Parliament, and in any instrument, document, or proceeding, it shall be sufficient to use the words and figures following, that is to say, "The Designs Act, 1850."

IMPROVEMENTS IN FORGING IRON.

By James Nasmyth, Esq.

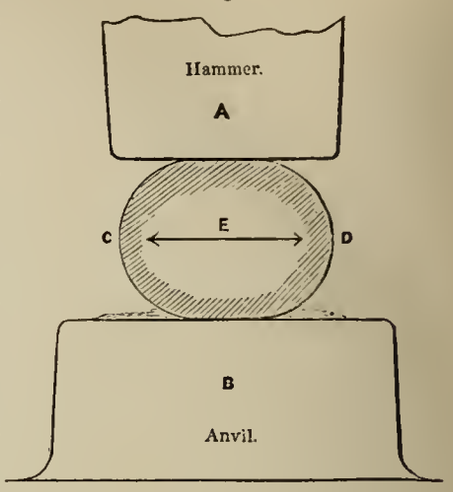
[The importance of this paper, in connection with workshop practice, is, we presume, sufficient to render unnecessary any apology for giving it a more prominent position than it would occupy in our usual report of the proceedings of the British Association.—Ed. P. M. Journal.]

Before proceeding to describe the nature of these improvements, Mr. Nasmyth made some remarks on the value and importance of any contrivance which tended to increase the certainty of the production of sound and perfectly solid forgings of wrought-iron, more especially those massive forgings required for such purposes as paddle-shafts for marine engines, crank and plain axles for locomotive engines, anchors, and such like, on the soundness of which both life and property, to a vast amount, may depend, and instanced several cases in which paddle-shafts of marine engines had given way, although, in the first instance, they had all the *outward* aspect of the most perfect soundness. On fracture, however, they exhibited the existence of original defect, in being little else internally than a mass or bundle of loose bars of iron which had never been in a sound welded union, but had only been held together by the exterior, where alone the welding had been so far perfect.

The chief cause of such defects was traced to the action induced on the central part of the metal, by the action of hammering such cylindrical forms between two flat surfaces, as in the case of a forge hammer and anvil of the ordinary construction.

Mr. Nasmyth exhibited the diagram, fig. 1, in order to illustrate the action induced on the central portion of a cylindrical forging, when produced under the action of a flat-faced hammer and anvil.

Fig. 1.



It will be seen at once, that the effect of the successive blows of a flat-faced hammer and anvil, as A and B, is to cause the work to spread out or extend in the direction, E D, E C, as represented by the double-pointed arrow in the figure; and as the flattened-out form has to be attempted to be corrected by turning the shaft round and round on the anvil, so that each successive blow may be made to correct the spreading out caused by the previous blow, the result of this action is a fretting or mincing of the central part of the metal of the shaft, resulting in a separation of the metal throughout the entire central portion of the shaft, somewhat after the manner indicated in fig. 2, frequently to such an extent as to permit the passage of air or water from end to end of shafts forged in this manner.

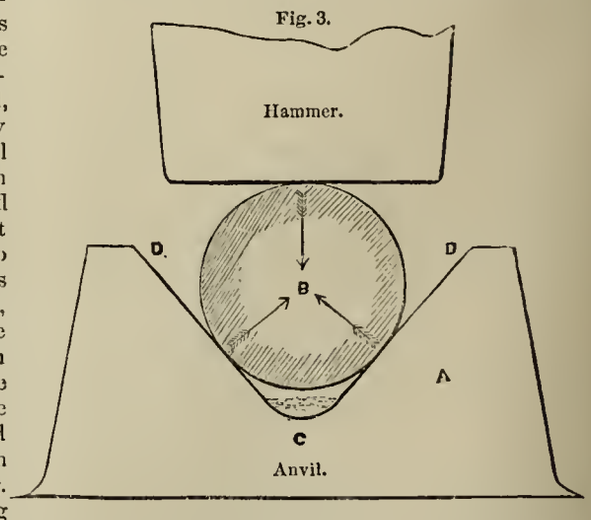
Fig. 2.

The effect of this kind of unsoundness is, that it is certain, sooner or later, to work out towards the exterior, and, in all probability, results in "a break down," more or less disastrous in its consequences.

Mr. Nasmyth then proceeded to describe his improved form of anvil-face, by the employment of which all such defects as detailed above are avoided. Such has been the perfect success and excellent results which have attended the use of this anvil-face, that its adoption has become almost universal, and the production of absolutely sound, solid, wrought-iron shafts, of whatever magnitude, rendered equally easy as certain.

A, Fig. 3, represents the form of the anvil-face, which he terms a V anvil, and between the jaws of which the work to be hammered is placed, as indicated by a cylindrical shaft, seen in section, marked B. A glance at fig. 3 will no doubt render its action evident, namely, that the action of each blow of the hammer on the work, C, instead of causing, as in the case of fig. 1, a diverging action on the central portion of the work, occasions, on the contrary, a converging action, as represented by the three arrows; and instead of having the central portion of the metal of the shaft rendered less compact and solid by the action of the blows of the hammer, we have quite the contrary effect. Besides this, owing to the wedge-like form and action of this V anvil-face, the compressing effect of the blow is most importantly enhanced, and the ease and rapidity with which shafts and the like can be produced by such means is most remarkable, so much so as to enable the forgeman to hammer out, *at one heat*, by means of this V anvil, as much as would require three heats on the common flat-face anvil. The fork-like form of the V anvil affords vast convenience in keeping the work at all times right under the centre of the hammer, as it is turned round and round to receive the successive blows, which, in the case of work of the largest class, is a matter of no small trouble. Another advantage consists in the free passage, or exit, which is at all times preserved for the escape of the scales and impurities falling from the hot

Fig. 3.



iron during the process of hammering, and which scales fall down towards the apex of the V at c, and trickle away, thus removing the cause of blemish and roughness caused by such scales collecting on the face of the flat anvil, and getting beaten into the surface of the forging.

It will be seen, on inspecting fig. 3, that one such V anvil-face will accommodate a vast range of diameters of work; namely, all diameters such as will neither absolutely rest on the bottom of the apex, c, or on the corners, D D.

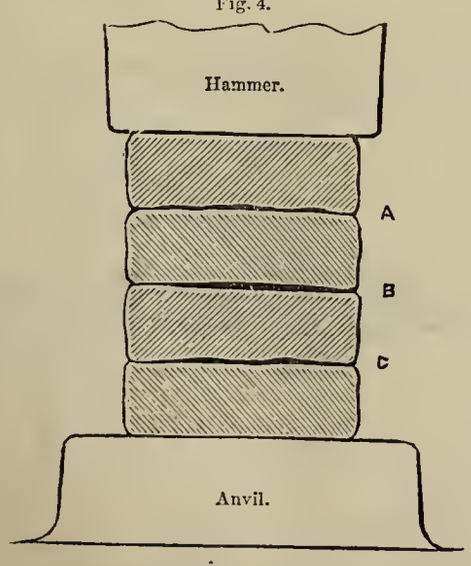
The inventor stated that an angle of 80 degrees was found by him to be most generally suitable for the inclination of the sides of the V, and also that the edges should be well rounded off, and the surface of the V sides curved in the direction of the axis of the work to the extent of $\frac{1}{8}$th of an inch in 12 inches, to facilitate the extension—axis ways—of the work.

Mr. Nasmyth next proceeded to describe the second part of his improvements in forging iron, which consist of means of producing sound boiler plates. He prefaced the description of his improvements on this truly important subject, by detailing the nature of the most frequent cause of unsoundness of iron forgings generally, and in boiler plates in particular, namely, the imperfect expulsion of the molten oxide of iron or scoria, or cinder as it is termed, which, in every case of welding hot iron, covers and clings to the surface of the metal, and if left interposing between the welded surfaces, is certain to occasion a defect, greater or less, according to the surface of junction it occupies. The frequency of this interposing scoria, as the true cause of unsound forged work, was forcibly alluded to, and shown to be the most fertile source and cause of the failure of wrought-iron work, resulting, as such too frequently does, in the most sad and disastrous accidents, such as the failure of the links of chains and anchors, and in the costly and often distressing casualties arising from defective or blistered boiler plates. With respect to the links of chains, he mentioned, as the result of an extensive series of experiments on the strength of chain cables, on which, as a member of the committee on metals, he was employed by the Admiralty, that out of every ten cases of fracture, eight were occasioned by defective welding, as evinced by the appearance of the surfaces, showing that the oxide or scoria had not been duly expressed.

Mr. Nasmyth further described the condition absolutely requisite to perfect welding, namely, not merely that the surfaces we desire to weld should be really welding hot, but also that, when brought into contact, no particle of the scoria, which inevitably clings to the metal while welding hot, should be permitted to remain interposing between such surfaces. If such material is left interposing, we are certain to have defect and unsoundness to a greater or less extent as the result.

In order the more clearly to detail his improvements on this important subject, a coloured drawing, representing the usual form and arrangement of a pile of slabs, such as are employed in forging, when welded together, a mass of iron from which boiler plates or bars of iron are rolled, was exhibited. Fig. 4 represents such a pile of slabs, which having been, as is generally the case, produced under the action of a forge hammer and anvil, having flat—or, as is generally the case, slightly convex surfaces, cause the slabs so produced to have certain hollow or slightly concave portions of their surfaces, so that when piled one upon the other, as in fig. 4, the risk of having hollow spaces between is almost certain. The hollow spaces are represented in the figure by the dark irregular lines between the slabs.

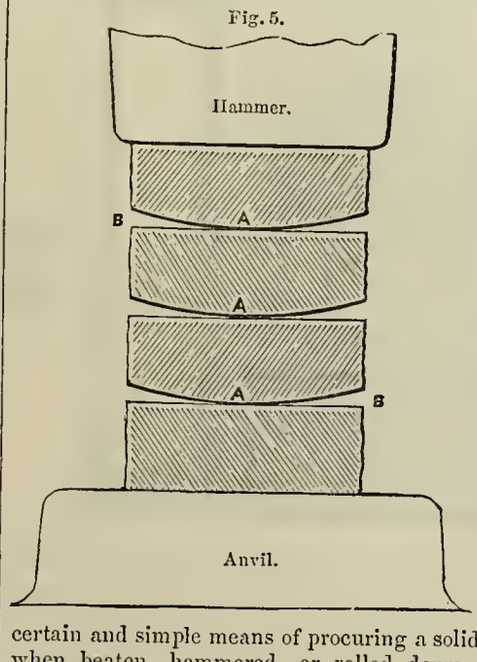
Fig. 4.



Referring to fig. 4, A B C represent a pile of four slabs laid on the anvil welding hot. Owing to the *concave* irregularities of the surfaces, the parts most certain to come into contact first, are generally the exterior edges of the slabs. The effect of the blows of the hammer is first to weld the parts in natural contact; and, by continuance of the blows, the interposing scoria or cinder is expressed in a degree more or less perfectly, according to the energy of the blows, and the deepness of the convex or hollow patches betwixt the slabs. So long as there exists an exit or passage for this scoria, all is well; but, as generally happens, some portion of this scoria lurks behind, after all chance of escape is removed by the welding of the exterior portion of the surface of the slabs. The result of this is, that we have, to a certainty, a defect greater or less in amount, according to the quantity or surface over which the *enclosed* scoria extends. Once such scoria is shut up between the surfaces of the slabs, no amount of after hammering will ever expel it, but, on the contrary, will only tend to its extension over a larger surface; and, as before said, so long as a particle of this scoria is left interposing, so have we a degree of unsoundness in proportion.

Great as this evil is, and common as it is, as a fertile cause of defective iron-work, and the more especially so in the case of boiler plates, the means of avoiding such source and cause of defect is as simple as the results are important; and it is to be hoped, that the free and open communication which Mr. Nasmyth has made of his views on this subject, will be answered in the most acceptable way by the general adoption of the improvement. These improvements consist simply in so forming the surfaces which we desire to weld together, that a free exit may be preserved to the last, for the escape of the molten oxide or scoria, until the entire surfaces of the parts we desire to weld are thoroughly incorporated by the welding property, aided by the action of the hammer or rolls, as the case may be.

Fig. 5.



In order to accomplish this most important and desirable object, the surfaces of the slabs are made *convex* (see fig. 5), by which most simple means a perfectly free exit to the scoria or interposing impurity is maintained to the last moment—the welding commencing at the central part of the contact, A, and extending outwards towards the edges, under the action of the successive blows of the hammer or squeeze of the rolls; but, as before said, an open door is kept for the escape of the scoria, until the surfaces unite *from* the centre, A, *to* the outside edge, B B. Here, then, by an arrangement or formation of the surfaces, we have the most certain and simple means of procuring a solid sound mass of iron, which, when beaten, hammered, or rolled down to whatever thickness we desire, will retain to the last all the qualities of one sound solid mass.

SIMPSON & SHIPTON'S SHORT-STROKE RECIPROCATING PENDULOUS ENGINE.

We have already noticed one modification of this ingeniously-arranged engine, which may be described as a species of compromise between the ordinary reciprocating and pure rotatory classes, for it actually belongs to neither.* It is simply a "short-stroke reciprocating engine," with the peculiarity that the piston and crank are combined in one, so that the piston is really its own crank, as it contains within itself two clearly distinct motions—rectilinear and revolving. Contrary to the ideas of most of the modifiers of steam mechanism, the inventors of the present engine have endeavoured to approximate as closely as possible to the well-tried reciprocating action, with the intention—1st, that the power of the steam should be conveyed to the main shaft or axle in the most direct and simple method (taking the oscillating engine as a fair example); 2d, to construct such an engine that it may with safety be worked up to an extraordinary number of revolutions, without causing the piston to travel through an excessive amount of space; 3d, to arrange such a plan that the steam may be used expansively, without inconvenience and complexity of parts; 4th, to take care that no amount of the piston's surface should be in rubbing contact, except that which is the real effective portion under the action of the steam (which the inventors consider is only the case with the common cylinder and piston-engine, and the one under notice—hence the excess of friction in most of the former

* See vol. ii. p. 135 and vol. iii. p. 46.

modifications); 5th, to form certain parts of the engine to act as fulcra to the moving parts, so that the whole lifting power may be self-contained, and thereby secure a steady, fixed, and uniform motion; 6th, to provide against any excess of wear of one part more than another, and all those parts, both internal and external, to be easily repaired, or even replaced, without renewing heavy parts of machinery, such as cylinders, &c.; and also that no crooked forms and contrivances need be resorted to, to bring back the first motion into a safe and useful form, such as guides and crossheads, or parallel motions, or even the fact of a piston rod giving out its power at a considerable angle, when the crank is most effective, thus altogether depending upon the length of the connecting rod, the evil of using short rods being generally admitted.

The example of the new arrangement already given has a fixed cylinder, and bears the same relation to its class of short-stroke reciprocators, as exists between the ordinary fixed cylinder engine in comparison with the other modifications of the old reciprocating class. The one we now illustrate has a pendulous cylinder, as in the common vibrating engine. Fig. 1 of our engravings represents a side elevation of the engine, and fig. 2 a corresponding view at right angles, partly in section.

A A, Are the two trunnions upon which the cylinder, B, swings in its

Fig. 1.

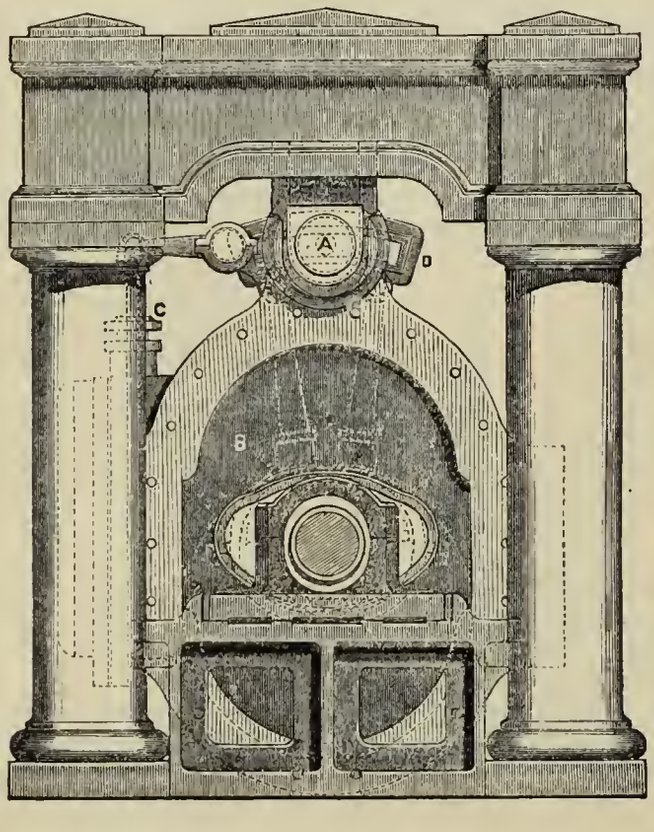
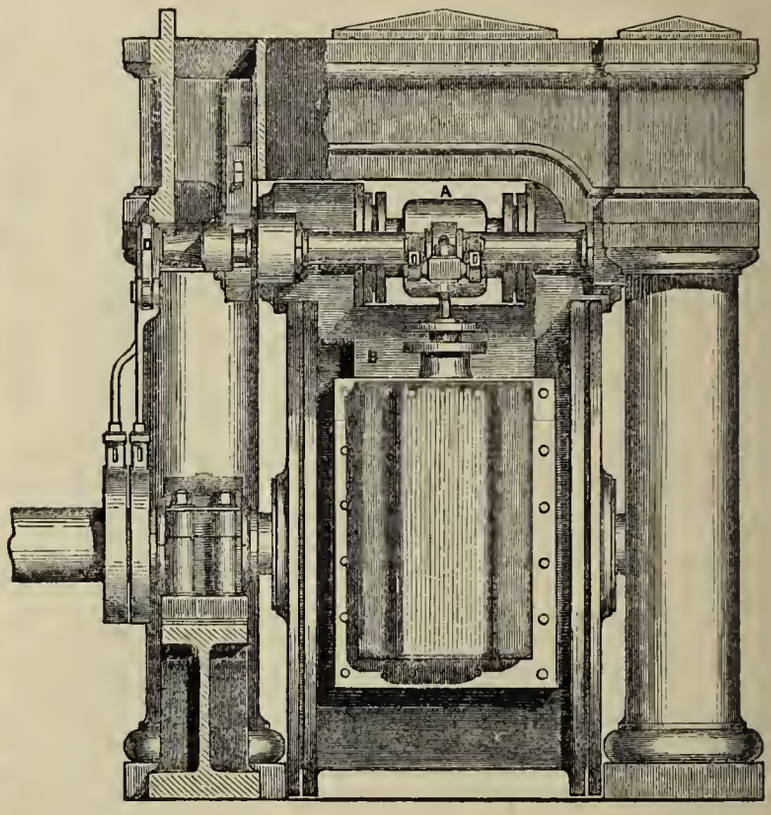


Fig. 2.



pendulous action. C, Is the slide-valve, worked upon the principle commonly applied to oscillating engines by the curved link, D. The steam is supplied by the pipe marked A, in fig. 2, between the two trunnions—one of which has the steam, and the other the exhaust passage in it. The cylinder moves over the shaft by means of a slot, as in the fixed cylinder arrangement—the shaft being carried in stationary bearings in the lower part of the framing.

One of the fixed cylinder engines has been in regular work at Wolverhampton for seven months, driving a saw-mill. Another is at work at Mr. Ellis's foundry in Salford, placed alongside a common high-pressure engine. The two are worked from the same boiler, and are alternately employed in driving a seven-feet fan, with fifteen arms, running at 600 revolutions per minute. The ordinary rate of working of the Wolverhampton engine is 110 revolutions per minute, giving a speed of the piston of about 200 feet per minute, but it has worked easily up to 400 feet per minute. We believe that one of these engines will be displayed in the forthcoming great exhibition.

THE MECHANIC'S LIBRARY.

Agricultural Referee, The, royal 8vo. £1 5s. cloth. L. Cooke.
Algebra, Elements of, Key to, 12mo. 5s. bd. Bonnycastle.
Arithmetical Companion, 3d edit., 2s.; Key, 1s. 6d. cloth. R. Hiley.
Chemistry, Annual Report of the Progress of, 17s. Liebig & Kopp.
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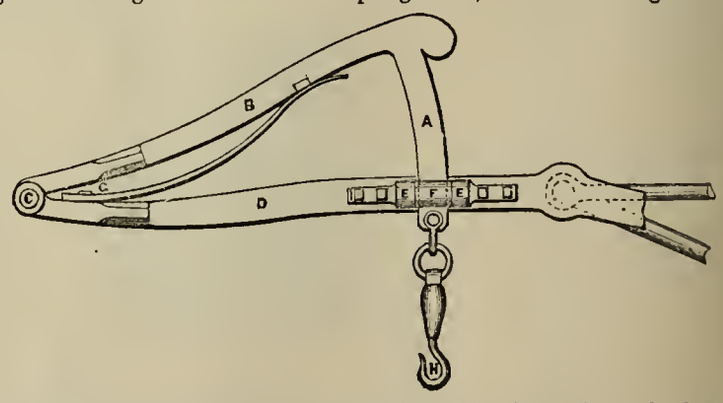
Mineralogy, System of, 3d edit., royal 8vo. 24s. cloth. J. D. Dana.
Natural Philosophy, Lectures on, new edit., 2 vols., 8vo. 12s. M'Gaulcy.
Sugar, Art of Manufacturing and Refining, with Atlas, folio, £3 3s.

REGISTERED DESIGN.

DRAW-SPRING LEVER FOR HORSE-POWER MILLS.

Registered for Messrs. R. Gray & Sons, *Uddingston.*

The irregular pull of the horses working thrashing-mills, and similar kinds of farm mechanism, is recognized as most objectionable in its effects upon the wheel-gearing, and other details of the mechanism through which the strain passes. To remedy this, Messrs. Gray & Sons, the eminent agricultural implement makers, have introduced the ingenious arrangement of a "draw-spring lever," of which we give the



annexed plan, on a scale $\frac{1}{8}$th of its real size. The figure shows the draw-hook, spring-lever, and a portion of the main mill-lever, as broken away.

The angular lever, A B, is hinged or jointed at C, to the double eye on the extreme end of the main lever, D. The short arm, A, is formed to a

curve, struck from the centre of the joint, C, and the upper side of the lever, D, is cut out to receive it, so that its surface is flush with the surface of the lever. At E E, are two small bearings to carry the spindle of the roller, F, which assists in keeping down the arm, A, and prevents the friction which would otherwise arise from the upward pressure of the arm. At G, a single blade-spring is attached to the lever, D, being bent so as to cause it to bear against the longer arm of the lever, A B. When the pull of the horses comes upon the hook, H, attached to the end of the arm, A, the spring relieves the machinery from the sudden strain, and regulates the effect of the power, whilst the connection of the arm, A B, at the extremity of the mill-lever, D, allows the horses to exert a better effect upon the latter.

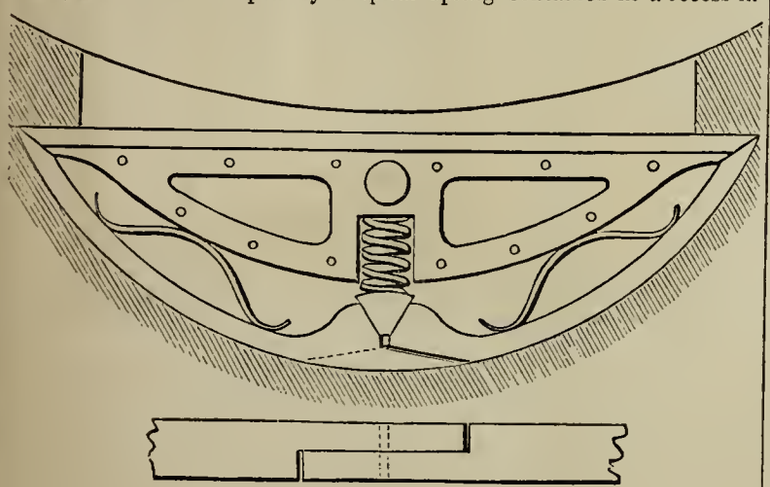
This elegant little contrivance will be very useful under various adaptations, where the irregular action of horses is the impelling power.

CORRESPONDENCE.

METALLIC PACKING FOR D SLIDE VALVES.

I believe a successful application of metallic packing to D slide valves is not of very common occurrence; that, however, which I proceed to describe, has, I am assured, answered very well indeed. It appears a well-devised plan, and when I saw the valves pulled out, and taken to pieces, they were in fine order. The slides in question are the work of Messrs. Fawcett & Preston, and are fitted in the *Malta*, Peninsular and Oriental Packet.

The accompanying sketch represents the upper side of either portion of the slide—it is a short D—with the covering plate removed. The packing consists of two segments of cast-iron, with a V block between them, which is acted upon by a spiral spring contained in a recess in



the body of the valve. The joint between the ends of the two segments is checked in a very simple and effective manner, which, I think, the sketch sufficiently explains, the action of the V block not being at all interfered with. At the other end of each segment its inner face is bevelled off, so as to act as a wedge against the corresponding part of the body of the valve, by which the tightness of the steam-joint at that part is insured, whilst the V provides for the contact of the extreme corner. Two plate springs are added, as shown. It appears, I think, from this arrangement, that a very moderate degree of tension on the springs will be sufficient to produce a steam-tight joint, so that the friction will be little, and the elasticity of the packing great.

The slide-valve rod is provided with two cones, which fit into corresponding conical eyes in the two portions of the valve, and are secured by a large nut under each; but it would probably be better if the connection were either such as to allow a little play, or, at any rate, such as to prevent the possibility of the placing the valve faces in winding with each other in putting the parts together, which might happen with a turned fitting like the present.

The segments of the packing are of cast-iron, and work against the back of the casing, which is of the same material. The faces of both valve and cylinder are of brass, pinned on. The segments are about three inches deep, and in other respects the valve differs not from the common sort. It is wrought by a hanging starting-bar, and is easily moved. The engines are of about 420 horse-power. The sketch is from memory, but is not in error in anything of the least importance to the principle of the design.

ENGINEER, R.N.

August, 1850.

WHITELAW'S STEAM-ENGINE EXPANSION-GEAR.

The appearance in the *Practical Mechanic's Journal* of a letter from Messrs. Petrie & Co. of Rochdale, in reference to my expansion-gear—although already answered editorially—seems to call for some remark from me, and I shall therefore be glad if you can allot me a small space for the purpose.

The letter in question contains a statement to the effect that, until the appearance in your pages* of the article descriptive of my invention, and advocating my claim to the credit thereof, the riters were totally unaware, not only of its previous publication, but of its very existence. How am I to reconcile this assertion with the assurances which I have received from parties connected with the Pleasley Works, near Mansfield, where one of Messrs. Petrie's engines with *my* expansion-gear is now at work, that they had themselves mentioned the matter to the makers, as well as to the foreman from their establishment who erected the engine? But even were this not the case, I really cannot see how the Messrs. Petrie's case is at all strengthened, as, if a contrivance is re-invented, and patented, subsequent to the publication of the original plan, such patent is invalid.

I have examined pretty minutely the engine erected by these gentlemen at the Pleasley Works, and I have found that its expansion-gear is the same as that published in your May part; I may therefore repeat a remark you have already made, by begging to know "in what respect their plan is an improvement upon the original." I have seen the contract for the engine, and the little clause specifying a charge of £1 per horse power, as royalty for the use of a contrivance of my invention, did not escape me.

The "competing engine-builder from a neighbouring town," doubtless views the matter in the same light as I do, and probably further agrees with me, that as far as the *law* is concerned, all that the Messrs. Petrie have to do with it in this case, is to investigate to what extent its powers can be exerted, in effecting a restitution of the royalty.

As to the observations on the indistinct similarity between the two arrangements, I need offer no remark, except to state that the only existing difference is, that Messrs. Petrie do not seem to have copied one or two of my later improvements.

JAMES WHITELAW.

Johnstone, August, 1850.

WIRE-ROPE RAILWAY SIGNALS.

Permit me to inform your inquirer, page 112, that the wire signals were applied on the Manchester and Leeds Railway in 1843, by Captain Binstead, the superintendent; and, I believe, this is the earliest instance. Instead of distances of 100 or 200 feet mentioned by you, his were 500 or 600 *yards*. He also broached the idea of having the red signals always on at junctions of more than one branch, so that every train was obliged to stop till its proper signal was given. I write this from a desire to do justice to an old friend, as I firmly believe that the freedom from accident, which so characterized this railway for many years, was mainly due to these admirable contrivances.

SUUM CUIQUE.

Halifax, August 12, 1850.

[We owe our thanks to our correspondent for his attention in furnishing us with this information. Too often the real inventor of an ingenious arrangement becomes involved in obscurity; and we are glad that, in this instance, we are enabled to give Captain Binstead the credit to which he is so justly entitled.—ED. P. M. JOURNAL.]

LIFT-APPARATUS FOR THE ORION.

I see in the last number of the *Practical Mechanic's Journal*, a scheme by Mr. Simpson, for raising the *Orion* steamer; may I therefore beg you will afford me a little space for the explanation of my plan for the same purpose.

I would place two large steamers parallel to each other, and connect them transversely by two trussed beams, carrying nuts for four stout vertical screws. Two chains are then to be passed beneath the keel, the four ends being fastened to the bottom ends of the screws. In this way I think the ship might have been elevated by turning the screws, fastening the ends of the chains to the trusses, when the screws require shifting downwards for another lift. By this arrangement, I think in six days the *Orion* might have been taken into Greenock harbour.

Tranent Cottage, August, 1850. P. M'NICOL.

* Page 28 for May.

ACTION OF MERCURY ON GLASS.

I have bought a quantity of mercury for the purpose of making steam guages, but the glass becomes so dirty, from the action of the mereury, that I can't see the height of the latter. I have washed it well in water, by placing it in a shallow pan, and running a stream of water into it. I have also tried boiling the mercury; also straining it through leather; but after all this it is as black or dirty as ever, if not worse.

R. B.

Lincoln, August, 1850.

PRESERVATION OF THE TINTS IN WATER-COLOUR DRAWINGS.

Can you, or any of your numerous eorrespondents, inform me what to apply to water-colour drawings, to prevent the tints from being disturbed in the proeess of varnishing?

J. A. G.

Bristol, August, 1850.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—TWENTIETH MEETING.—EDINBURGH, AUGUST 1, 1850.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

President—Prof. JAMES D. FORBES.
Vice-Presidents—Sir T. M. BRISBANE, Bart., Bishop TERROT, Prof. W. THOMSON, Lord WROTTESLEY.
Secretaries—Prof. STEVELLY, Prof. G. G. STOKES, Mr. W. J. MACQUORN RANKINE, Prof. SMYTH.

Committee—Mr. J. C. Adams, Sir David Brewster, Mr. J. A. Broun, Prof. Gray, Mr. J. P. Gassiot, Rev. Dr. Hincks, Rev. Prof. Kelland, Dr. Lee, M. Otto Struve, Mr. F. Osler, Prof. Phillips, Rev. Dr. Scoresby, Prof. Wilson, Mr. J. Scott Russell, Rev. J. B. Reade, Mr. F. Ronalds, Col. Sykes, Lieut. R. Strachey, R.E.

Prof. Forbes, the President, being confined by severe illness, Lord Wrottesley, on taking the chair, called on Mr. F. Ronalds for his report on the "Observations and Experiments at the Kew Observatory."

This report, which was voluminous and elaborate, detailed the arrangements of the buildings, and the improvements which had taken place during the last year; the instruments, and the peculiarities of their construction and late improvements, the most important of which was, that, by the use of transparent gelatine paper, a light line could be etched on it exactly corresponding with the curve traced by any of the self-registering instruments, which piece of gelatine paper being then sent to the copperplate printer, he was able to strike off from it any number of copies that might be required for distribution.—Prof. Phillips then gave a sketch of the observations which had been established under the unpaid and invaluable superintendence of Mr. Ronalds since 1842–3, when the observatory was placed by government at the disposal of the British Association. He gave a brief description of the manner in which a piece of photographic paper, being carried by clockwork across the direction in which the instrument moved whose changes were to be noted, received a succession of impressions which appeared as a curved line, recording the several indications of the instrument as the time elapsed.—Sir D. Brewster wished to suggest to Mr. Ronalds that, by taking a negative impression of the positive photographic curve, copies might in a much simpler manner be multiplied to any extent—as was now practised in this city; and he promised to exhibit specimens on some future occasion to the Section.

"On the Laws of the Elasticity of Solids," by W. J. Macquorn Rankine. The object of this paper is to investigate the relations which must exist between the elasticities of different kinds possessed by a given solid substance, and between the different values of these elasticities in different directions. The different kinds of elasticity possessed by a solid substance are distinguished into three: first, *longitudinal elasticity*, representing the forces called into play in a given direction by condensation or dilatation of the particles of the body in the same direction;—secondly, *lateral elasticity*, representing the force called into play in a given direction by condensation or dilatation of the particles of the body in a direction at right angles to that of the force;—and thirdly, *transverse elasticity* or *rigidity*, being the force by which solid substances resist distortion or change of figure, and the property which distinguishes them from fluids. The author's researches refer chiefly to substances whose elasticity varies in different directions. His first endeavour is to determine the laws of elasticity of such substances, as far as they are independent of hypotheses respecting the constitution of matter,—a method which has not hitherto been followed. The first proposition respecting such substances is the following:—*Theorem* I. In an elastic substance which is homogeneous and symmetrical with respect to molecular action, there are three directions at right angles to each other, in which a longitudinal strain (viz., dilatation or condensation) produces a pressure in its own direction. These three directions are called axes of elasticity. They are the proper directions for the reduction of all molecular displacements and pressures. Their existence has been demonstrated according to various hypotheses as to the constitution of matter; but the truth of the demonstrations is independent of the particular hypotheses. The elasticity of a body, referred to these three axes, is expressed by twelve coefficients—three of longitudinal and six of lateral elasticity, and three of rigidity, which are connected by the following laws:—*Theorem* 2. The coefficient of rigidity is the same for all directions of distortion in a given plane.—*Theorem* 3. In each of the co-ordinate planes of elasticity, the coefficient of rigidity is equal to one-fourth part of the sum of the two coefficients of longitudinal elasticity, diminished by one-fourth part of the sum of the two coefficients of lateral elasticity in the same plane. The investigation having now been carried as far as is possible without the aid of hypotheses, the author determines, in the first place, the consequences of the supposition of Boscovich, that elasticity arises entirely from the mutual action of atomic centres of force. The author denominates bodies so constituted *perfect solids*, and, respecting them, proves the following propositions:—*Theorem* 4. In each of the co-ordinate planes of elasticity of a perfect solid, the two coefficients of lateral elasticity, and the coefficient of rigidity, are all equal to each other.—*Theorem* 5. In each axis of elasticity of a perfect solid, the coefficient of longitudinal elasticity is equal to three times the sum of the two coefficients of rigidity for the co-ordinate planes which pass through that axis, diminished by three times the coefficient of rigidity for the plane normal to that axis. Thus, in perfect solids, all the coefficients of elasticity are functions of *three* independent coefficients—those of rigidity. In no previous investigation has the number of independent coefficients been reduced below six. To represent the phenomena of *imperfect* solids, there is introduced the *hypothesis of molecular vortices*, in addition to that of atomic centres; that is to say, each atomic centre is supposed to be surrounded by a fluid atmosphere, retained round the centre by attraction, and diffused from it by the centrifugal force of revolutions constituting heat. The author has already applied this hypothesis to the theory of the elasticity of gases and vapours, in a paper read to the Royal Society of Edinburgh, and published in their Transactions, vol. xx. Applied to solids, it leads to the following conclusion:—*Theorem* 6. In an imperfect solid, according to the hypothesis of molecular vortices, each of the coefficients of longitudinal and lateral elasticity is equal to the same function of the coefficients of rigidity, which would be its value in a perfect solid, added to a coefficient of fluid elasticity, which is the same in all directions. Thus the number of independent coefficients is increased to four.—The rest of the paper is occupied by the deduction of some important consequences from these principles. This paper is intended to form the foundation of the theoretical part of a series of researches on the strength of materials.

Sir D. Brewster begged to suggest to Mr. Rankine, that by an examination of the action of transparent solids on polarized light, the correctness of these theoretic views might be tested or corrected; and so accurate and simple was this method found to be of testing the nature of the constraint under which the several elements of a strained body were, that models of pieces of carpentry were now actually constructed in glass, subjected to the kind of strain to which their representatives would be exposed; and the kind and degree at each part rigorously ascertained by polarized light.

SECTION B.—CHEMISTRY, INCLUDING ITS APPLICATIONS TO AGRICULTURE AND THE ARTS.

President—Dr. CHRISTISON, V.P.R.S.E.
Vice-Presidents—Dr. GREGORY, Dr. TRAILL, Dr. DAUBENY.
Secretaries—Mr. R. HUNT, Dr. G. WILSON, Dr. T. ANDERSON.

Committee—Dr. L. Playfair, Mr. J. P. Gassiot, Prof. Johnston, Dr. J. Stenhouse, Mr. J. P. Joule, Prof. Voelcker, Prof. Blyth, Messrs. S. Ward. T. Pearsall, Prof. Penny, Dr. Gladstone, Mr. A. Kemp, Dr. D. Maclagan, Messrs. J. Tennant, J. Young, H. L. Pattinson, H. C. Sorby, Dr. Schunck, Prof. Williamson, Dr. R. D. Thomson, Dr. Andrews, Prof. A. Fleming.

"On the Sugar Produce of the South of Spain, chiefly in connection with the employment of the Acetate of Lead and Sulphurous Acid as purifying agents," by Dr. Scoffern.—On the southern coast of Spain, in a region limited by Almeria on the east, and Malaga on the west, bounded on the north by mountain ranges, and on the south by the Mediterranean, is a tract of land which, so far as its climate and productions are concerned, may be aptly denominated tropical. In it the date, palm, indigo, cotton, and sugar-cane flourish with vigour, yielding products equal both in quantity and quality to those of the tropics themselves. The sugar-cane first introduced by the Arab conquerors is not only consumed in large quantities as a dessert, but also gives rise to a considerable manufacture of raw and refined sugar, a circumstance which, beyond Spain itself, seems to be very little known. There is perhaps no example on record of any operation involving a commercial result attended with such an enormous destruction of material, as the operation of extracting sugar from the cane. One portion of this loss is due to mechanical, another to chemical causes. The sugar-cane has been stated, by most writers who have found opportunities of practically examining the subject, to contain no more than 10 per cent. of solid non-saccharine matter, leaving 90 per cent. of juice to be extracted. Of this 90 per cent. most writers concur in testifying, that in practice scarcely 50 per cent. are actually obtained; at least in the British West India possessions. Cane-juice itself has usually been stated to contain from 17 to 23 per cent. of crystalline sugar, of which scarcely 7 per cent. in practice is actually extracted. Considerable doubts having been expressed as to these statements of the amount of juice in the cane, and sugar in the juice, I have lately gone through a series of experiments, having for their object the settlement of the doubt, and with the result of amply confirming the testimony of other experimenters. Having operated on canes from various parts of this district, by slicing them, exhausting first by hot water and then by hot alcohol, and finally drying, I obtained as my mean result about 10 per cent. of woody or insoluble matter—whilst the sugar extracted and crystallized ranged from 17 to 23 per cent., as had previously been stated. It would consequently appear that 40 per cent. of juice is actually lost in the practice of our West India workings; and now arises, as a most important consideration, the question as to what extent this loss is inevitable, and to what extent it might have been obviated by altered machinery or improved manipulation. Instead of 50 per cent. of juice extracted, 70 per cent. is much nearer the average amount yielded by the sugar-mills of this coast, although occasionally the result is as high as 75 per cent., and this, in some cases, with mills of very inferior con-

struction. The cane, however, is passed between the rollers of the mill four times, until the refuse or megass, as the pressed cane is called, has been reduced to a state of disaggregation resembling ground tan; whereas the West India cane refuse is represented to be in the form of long strings, a sufficient proof that the pressure applied has been very inadequate. After the cane has finally left the mill, it is immediately, in the Spanish sugar regions, subjected to the operation of pressing, sometimes by the agency of a screw, but in many cases by hydrostatic force. By the latter method, I have seen 13 per cent. of juice extracted from megass which had already yielded up 73 per cent. of juice to the mill, thus elevating the total quantity extracted to 86 per cent. out of the original 90, and consequently, as a manufacturing operation, leaving very little more to be desired. The hydrostatic press I consider to be an apparatus which is indispensable to the economy of every sugar estate;—not only does it largely contribute to the amount of juice extracted, but what is most remarkable is, the juice resulting from hydrostatic pressure of megass is invariably, so far as my observations have gone, richer in sugar than juice yielded by the mill,—a fact which seems to be only explicable on the supposition, that the hydrostatic press, in virtue of its great power, is enabled to extrude those particles of sugar which microscopic examination demonstrates to exist in the cane in the solid and crystalline form. The subsequent stages of the sugar manufacture, as carried on in Spain, do not materially differ from those in operation in Cuba, and many other tropical countries. The juice is defecated or purified by lime, skimmed, evaporated to the requisite degree, and poured into earthenware moulds, the contents of which are finally exposed to the operation of claying. In one manufactory, however, witnessed by me, at Almunecar, lime is no longer used, on account of its well-known injurious effects on sugar,—no other agent having been substituted in its stead, but sole reliance being placed on the coagulation by heat of albuminous matters present in the juice, and their final removal by skimming. Under this system of manufacture, the sugar produced is light-coloured, but badly grained: and the unseparated albuminous matters are at present in such quantity, that every 100 parts of the concentrated saccharine juice as it comes from the teache, or last evaporating pan, only yield 40 parts of crystallized sugar on cooling, the other 60 per cent. remaining in the condition of molasses, perfectly uncrystallizable until some adequate means for defecation be had recourse to. The chief object of my residence in this sugar district, was to superintend the erection of machinery for manufacturing sugar by means of my own process. The site of our operations is Montril, about forty-five miles south of Granada, in a manufactory furnished with apparatus of the rudest character. Up to this period (July 9), our own vacuum apparatus has not been sufficiently advanced to enable us to pursue our operations by its aid; nevertheless, owing to the superior defecating power of the sub-acetate of lead, we have, even with the old and rude machinery, obtained a result of more than 16 instead of 7 per cent. of sugar. Our striking teaches, or final evaporating pans, we were under the necessity of removing in order to afford the requisite space for our own machinery; hence we were reduced to the necessity of concluding our process of concentration in a brass pan of conical form, and holding about 600 imperial gallons, thus materially increasing the difficulty of the evaporative process. Hitherto only one-sixth per cent. on the juice of sub-acetate has been used; but I imagine the quantity may be advantageously increased. As filtration is indispensable for the conducting of this process, considerable fear was entertained lest fermentation might supervene. This fear, however, practice has demonstrated to be groundless, inasmuch as we possess in sulphurous acid an agent most antagonistic to fermentation. Another speculative fear was, lest danger might arise from the lead employed: this fear, too, practice demonstrates to be entirely without foundation, for not only is the sulphate of lead most easily removed, but even were it to remain no injury could supervene, inasmuch as this agent is as harmless as chalk.

Section G.—Mechanical Science.

President—Rev. Dr. Robinson.
Vice-Presidents—Mr. G. Buchanan, Prof. Gordon, Messrs. T. Grainger, J. Scott Russell.
Secretaries—Dr. Lees, Mr. D. Stevenson.
Committee—Messrs. Taylor, J. Nasmyth, R. Napier, — Roberts, J. Leslie, Prof. Fischer, Major-General Pasley, Mr. T. Stevenson.

The President opened the meeting by an exposition of the peculiar objects of this Section, and its relation to the other Sections of the Association. Originally this Section was merely a subsection of Section A. It was no sooner instituted, than the importance and number of the applications of mathematical and physical science to the practical uses of life, which were brought forward, raised it to an importance which has made it one of the most useful of the Sections of the Association. He believed that some of the most valuable of the measures of the Association had emanated from it, and some of the most important researches had been carried out by means of grants of money recommended by this Section.

"On the Value of the Gaseous Escape from the Blast Furnaces at the Ystalfera Iron Works," in continuation of a paper read at the meeting of the Association in 1848, by Mr. Palmer Budd.—Mr. Budd stated that, since the meeting of the Association at Swansea, he had continued, and with increased success, to apply the waste gases that escaped from the top of blast furnaces, to the manufacture of iron; and it was the result of his further experience applied to the whole of his furnaces (nine in number) since that period, that he now wished to submit to the Section. Mr. Budd then referred to his mode of applying the gaseous escape, and said it was well known that there were two descriptions of furnaces used for metallurgic purposes. The one was the blast furnace, into which air was injected, by mechanical means, at a great density, so as to penetrate upwards of 40 feet of dense materials; and the other was the reverbatory furnace, where the fire was produced by means of the draught of a chimney-stack. What he had accomplished was by combining these two, so that the gaseous products of the furnace, instead of escaping through the tunnel-head, were drawn sideways by a high stack, and passing through the stoves and boilers, leave behind the necessary temperature of the blast and of the steam. In a blast furnace the ores are smelted before the *tuyères* by the conversion of the solid carbon into carbonic acid, which, passing up through the middle region of the furnace into a bath of carbon, was re-converted into carbonic oxide, capable of combining with a further dose of oxygen. It would be thus seen that the whole of the carbon of the fuel should be present at the top of the furnace in a gaseous form. When the British Association met at Swansea, he had not used the gaseous escape at any great distance from the furnace, his stoves and boilers being very closely contiguous. Further experience, however, had proved that, by the aid of a stack at the end of the chain of sufficient dimensions, the gaseous escape from the furnace might be made to travel in the most tortuous directions, descending to the stoves built for heating by the usual fire-places, and traversing the boilers; the only condition absolutely necessary being, that there should be an unbroken communication with the high stack at the end, into which the gaseous escape might at last pass, and by which it was drawn forward, instead of passing off wastefully at the tunnel-head. When, however, the draft was carried downward, and to long distances, he had found it necessary to drop into the top of the furnace a hopper or funnel, made of sheet-iron, which acted as a shield at the mouths of the horizontal flues, and prevented them from either being affected by high winds, or from being choked up by materials thrown into the furnace. The reason, no doubt, why this funnel was not applied before, was the great apparent temperature at the funnel-head. In practice, however, it was found that, until the gaseous escape mingled with the atmosphere, its heating power was not such as to injure sheet-iron, or even to make it red-hot. In fact, so long as there was an escape upwards, the iron funnel would not be injured. The damage arose during and after stoppages of the furnace, when the blast was obstructed in its passage upwards by the settlement of the materials in the furnace, so that the atmosphere rushed down to meet the ascending gases, and, of course, caused a very high local temperature. His practice was to exclude the atmospheric air as much as possible. The affinity of the gases for oxygen was so great, that the air-leakage raised the temperature quite sufficient for safety, whilst the full combustion of the gaseous escape would melt down the bricks in the flues, and destroy the texture of the iron tube. It was not possible for him to say what combinations took place at high temperatures, where carbonic oxide, carbonic acid, hydrogen, and nitrogen, were mixed in such proportions. At any rate, he found a smothered combustion to be the most suitable and economical for the purposes in view. He was happy to say, that at length the application of the gaseous escape had been tried in Scotland; and that at Dundyvan and elsewhere it was now in successful operation. The peculiar quality of the furnace coal of Scotland being what was called in South Wales "free burning," which, when put into the furnace raw, coked sufficiently in its descent, gave out an enormous escape, so much so that, upon a rough estimate, he calculated that the waste from one furnace in Scotland was sufficient to heat the blast, and to raise the steam for three. With anthracite coal, the minimum effect was obtained, as it was a dense fuel of nearly 95 per cent. of solid carbon; but in Scotland there would be an enormous surplus at the tunnel-head. He observed that the saving at the Dundyvan Iron Works was stated to be about 1¼ ton for each ton of iron produced. Supposing, therefore, 600,000 tons of iron to be the produce of Scotland, and supposing the value of the coal used to be 3s. a ton, the saving that would thus be effected on the make of Scotland would amount to £112,500 a year; to which might be added £20,000 a year of saving in wages and repairs, which would make a total saving of £132,500, or about 4s. 5d. a ton on the produce of Scotland, which, on the present price of 44s. per ton, was about 10 per cent. on the value. If the gaseous escape could be extended to the uses of the forge, a further saving of three tons of coal would be effected,—thus making, at least, a saving of 20s. a ton on all the iron manufactured into bars, sheets, and rails.

The Tubular Bridge.

An interesting discussion arose on the subject of the party to whom the priority of the discovery of the principle of the Tubular Bridge should be assigned. The discussion arose in consequence of the President of the Association (Sir D. Brewster) having communicated the substance of a note which he had received from Mons. Jules Guyot, claiming the priority of the invention of the tubular bridge, and contending, it would appear, that English engineers had stolen the idea from him. If engineers should consider the junction of hollow parallelopipeds the same in principle as the tubular bridge of Fairbairn's, then Guyot might have some claim to the invention.

Mr. Rankine stated, that the late Mr. Andrew Thomson of Glasgow, so far back as 1840, had constructed hollow girders of boiler plates, between which were formed arches of brick to carry a road over the Pollock and Govan Railway: nor did the invention of the girder lie with him even; it was traceable to some time prior to this period, when such girders had been used to form bridges between blast furnaces at iron works.

Major-General Sir Charles Pasley said, that Mr. Stephenson laid claim to the invention of iron girders, whether great or small, and upon this he rested his claim to the invention of the tubular bridge. He had seen his first idea, which was rejected by the Admiralty, because of its not affording space enough for the navigation of the strait. His next idea was two oval tubes, resting upon a pillar on the Britannia Rock, through which the road would pass. He believed that up to this time no idea had been formed of a tubular bridge. The next step was the rectangular form, which was shown to be the best by the experiments of Fairbairn. He thought that the particular form was due to Fairbairn, while he believed the original idea of the tubular bridge to be due to Stephenson.

Sir D. Brewster observed, that if Stephenson admits (which he seems to have done) that the invention of the girder was the invention of the tubular bridge, then it certainly did follow that, just as a telescope of a foot long was as much a telescope as that of Lord Rosse's, that the invention was due to Stephenson. He did think, however, that Stephenson had claimed too much; and the risk was, he would get credit for less than was his due.

General C. Pasley was afraid that Mr. Stephenson may have grasped at too much, and might, in consequence, get credit for less than he was, in his opinion, entitled to.

Dr. Robinson remarked, that if the letters arising out of the controversy touching this affair between Stephenson and Fairbairn were to be relied on, he certainly did think that Stephenson had extended his claims too far. It did appear to him (Dr. Robinson) that up to a late period Mr. Stephenson had no idea at all of any other than the tensile force, and that the resistance to a compressive force had not yet entered his mind. His idea of auxiliary chains seemed to indicate as much. The grand idea of a tubular bridge at this time he certainly had not.

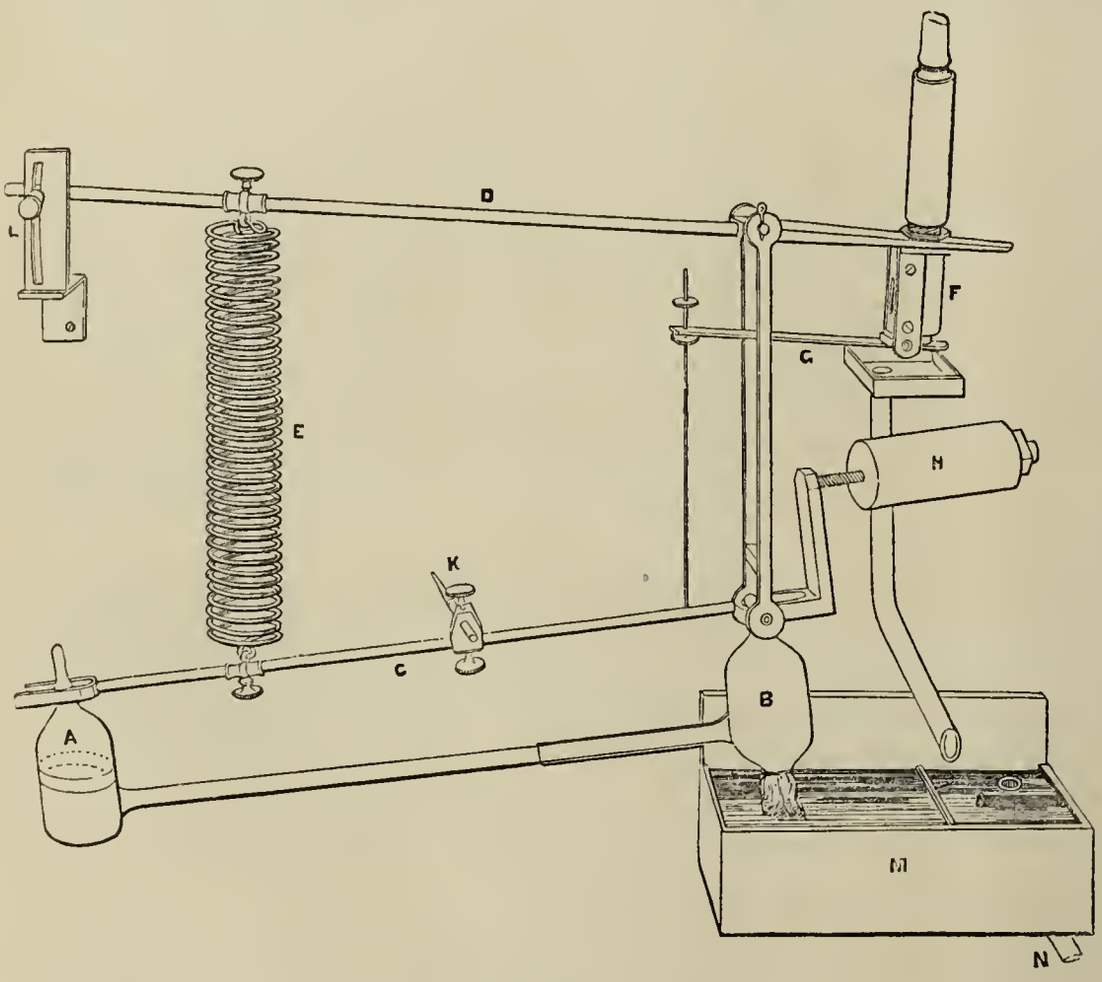
The Astronomer-Royal (Professor Airy) expressed his great regret that a controversy of this kind had been admitted into the British Association. He protested against all discussions of this kind, as being foreign to its objects, and calculated, in no small degree, to disturb the harmony of its deliberations.

Sir D. Brewster having been boldly told, when in France, that the idea of the tubular bridge had been stolen by the English, he felt bound to defend his countrymen from such an allegation. He did not see why the discussion could not be conducted in kindness, and with the simple idea of determining the truth. He could not sympathise with the Astronomer-Royal in his protest against such discussions being entered upon in the British Association.

Here the discussions were likely to become so warm, that Dr. Robinson, the president of the Section, brought them to a close, much to the regret of many present.

"On a Register Hygrometer for Regulating the Atmospheric Moisture of Houses," by Mr. Appold.

This instrument, with a variation of one quarter of a degree in the hygrometric state of the atmosphere, opens a valve capable of supplying ten quarts of water per hour, conveying it on to the surface of warm pipes covered with blotting paper, by which the water is evaporated until the atmosphere is sufficiently saturated, and the valve thereby closed. A lead pencil attached, registers the distance the hygrometer travels, and thus a sheet of paper moved by a clock would show the hygrometric state of the atmosphere at any period of time. The instrument is made with two bulbs of a cylindrical shape, 1 inch diameter, and $1\frac{1}{4}$ inch long, placed vertically, so that the surface of the mercury may always be the same size. The bulbs are about nine inches apart, with mercury enough in them to fill one, and connected together by a glass tube, that the mercury may flow freely from one to the other. A little ether is placed in each bulb, the remaining space filled with the vapour from the ether. The bulbs are fixed upon a balance, so that when one bulb becomes warmer than the other, the ether forms vapour in one, and condenses in the other, by which means the mercury is driven from one bulb to the other. It will be observed that the wet bulb is placed under the fulcrum, for the purpose of keeping it always in contact with water; the other end is held up by a spring, connecting the two horizontal levers, so that it can be adjusted to agree exactly with the action of the mercury: this is done with both bulbs dry, and made to stand in any position—the spring counteracting the weight of the mercury. When in use, the spring and levers are lowered, allowing as much mercury to flow into the dry bulb as may be required: the dryer the atmosphere is required to be, the lower the dry bulb must be placed. The valve is fixed to one end of the top lever, that the lever which opens the valve may be always in the same situation relative to the hygrometer. In the place to which it belongs, the water is laid on with a gutta percha pipe. The brass vessel at the top serves for a temporary cistern, to show the action of the valve.



REFERENCE:

A, The dry bulb.
B, The wet bulb.
C, Lower lever.
D, Upper lever.
E, Spring connecting the two levers.
F, Valve.
G, Valve lever.
H, Weight.
K, Pencil.
L, Set screw for upper lever.
M, Cistern that receives the water from the valve, the overflow of which goes on to the pipes.
N N, Overflow pipe.

MONTHLY NOTES.

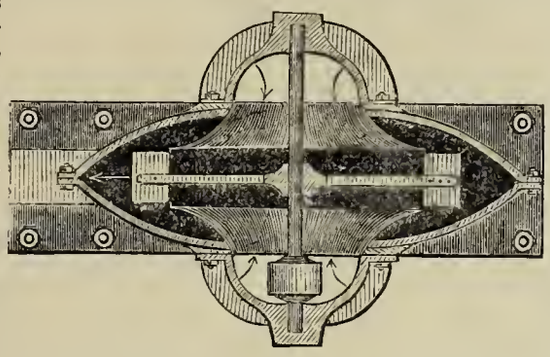
NASMYTH'S DETACHED ENGINE SYSTEM FOR PRINT-WORKS.—In many manufacturing works, more especially those in which the operations of dyeing, printing, and finishing are carried on, one of the first requisites is, that the attendant should at all times have direct and immediate control over the power which drives the machine under his charge, so that he may start or disconnect any single movement at pleasure, without interfering with the regular operations of the others. It is also of great advantage to be able to regulate the rate of movement of such machinery to suit the particular work in hand. Under what may be termed the inflexible stationary engine system, where one large prime mover gives off its power to a great variety of machines by means of ranges of shafting, the requirements we have stated cannot be properly carried out, as the stoppage or variation in the speed of any one machine inevitably produces some effect upon the rest, and the only attempt to mitigate the evil has been that of the application of friction clutch-boxes as disconnectors. Mr. Nasmyth has given flexibility to factory arrangements of this class, by fitting a small separate steam-engine to each machine, so that each workman is totally independent of his neighbour, and can adjust his rate of working, or suspend the action of this apparatus, without the slightest difficulty. We have seen the practical application of the arrangement to calenders, mangles, and printing machines, for which latter class of machinery it will be invaluable, as it enables the printer to ascertain how far the various parts of the pattern are in correspondence, by working at a slow rate, and the disengagement may be instantaneous without injury. Although the particular applications contemplated by Mr. Nasmyth are novel in themselves, we may remind him that Mr. Hastie of Greenock has already patented the detached engine system for corn and other mills. A drawing of his arrangement, as fitted up at the Cartsdyke Mills, Greenock, will be found at page 84 of our first volume.

BRODIE'S PIPE AND TILE MACHINE.—We are glad to perceive that the Highland and Agricultural Society of Scotland, at their show held in Glasgow, the 30th and 31st of July, and 1st of August last, awarded Mr. Brodie the first prize for this machine, as the best pipe and tile machine exhibited; and we are also informed, that the gentleman who obtained the first prize for the best pipes and tiles, had them manufactured by the first of these machines, which Mr. Brodie disposed of after his registration, this being a convincing proof that the best quality, as well as the greatest quantity, of pipes and tiles, can be obtained by the use of this invention.

LESTER'S SPIRIT FILTERING FUNNEL.—This is a newly-registered improvement in funnel or filtering apparatus, which will be found of considerable use in filtering evaporative liquids, as spirits and perfumes. The old

shape is retained, but the cover or lid of the receiver is formed in two parts, and two tubes are arranged, one in the inside, passing down the funnel neck, and the other outside to admit air to increase the pressure and keep the liquid flowing during filtration.

American Blowing Fan.—Among the great variety of forms of fans, one, which has very recently been issued in Philadelphia, is certainly worthy of the particular notice of the manufacturer. The wings of this fan are encased in a separate box; a wheel is thus formed, which rotates in the outer box. The woodcut shows a horizontal section through the axis. The wings are thus connected, and form a closed wheel, in which the air is whirled round, and thrown out at the periphery. The inner case, which revolves with the wings, is to be fitted as closely as possible to the outer case, at the centre; for no packing can, in this case, be applied, and there is a liability of losing blast, if the two circles do not fit well. This fan is decidedly better than the common fan, and is fast becoming a favourite of the public. As the building of this apparatus receives much attention in our machine shops, and as the leading principles involved in its construction are very little known, we shall designate such points as may be deemed of great importance by those who manufacture fans, which is frequently the lot of the iron manufacturer himself. The outer case should be strong and heavy; and the interior machinery, which revolves, as light as possible. For this reason, it should be made of the best wrought-iron, or, what is preferable, of steel. Four wings produce quite as much effect as a greater number. It is, therefore, useless to exceed that number. The greatest attention must be paid to the gudgeons and pans; it is advisable to make both of steel, or, better still, to run the two ends of the shaft in steel points. The wings are to be exactly at equal distances, and of equal weight; otherwise, the strongest case will be shaken. The surface of each of the wings should be at least twice as large as the opening of the nozzle at the blowpipe. The pressure of the blast from a fan is proportional to the square of the speed of the wings, with a given diameter of the fan. The pressure gains simply in the ratio of the diameter, or speed, provided there is the same number of revolutions. The increase of speed is in the ratio of the increase of the radius. The pressure in the blast is produced by centrifugal force. The atoms of air, after being whirled round by the wings, are thrown out at their periphery by a force equal to the centrifugal force resulting from the speed of the wings. This centrifugal force may be simply expressed by $\frac{C^2}{2gr}$: c is the speed in feet per second; g the speed of gravitation in the first second; and r the radius of the fan. According to this, the effects of a fan ought to be far greater than they actually are; therefore, a remarkable loss of power must take place in these machines. It is thus very clear that the increase of diameter augments the effect of the machine in a numerical proportion, while an increase of revolutions adds to the effect in the proportion of the square. It is also very clear, that an increased diameter greatly increases the friction, while the increase of speed does not augment it in the least. The friction, in these machines, is the greatest objection to their use: therefore, the moveable parts should be as light as possible. Friction increases in the ratio of the weight, where the materials are the same, but not with an augmentation of speed—at least, not in the same ratio. From practical observation, the following formula has been deduced: in which a is the speed of the fan—that is to say, it represents the number of feet which the wings make in a second; b, the surface of the nozzle; c, the surface of a wing; and d, the velocity of the escaping blast. This formula we conceive to be the proper dimensions of a fan:—



$$d = 0{\cdot}73 \times \sqrt{\frac{a}{\frac{b}{c}}}$$

—*Overman on Iron.*

Notes of the British Association's Excursion to the Bass.—Reach the railway-office ten minutes before nine—a little nervous about ticket, as it is merely a slip of paper manuscript, but clerk declares it all right. Rather a disorderly-looking mob on the platform. Find the apparent confusion proceeds from docile wishes of being subject to a leader, but no leader to be found. Several persons, self included, addressed by distracted individuals demanding who has charge? Observe that, in general, the idea of having any charge was repelled as insulting. Frantic individuals with no leader go into wrong train, and run risk of being carried to Glasgow, or somewhere. A train at last filled and despatched eastward. Plenty of time for meditation and conversation. Find general complaint that no Highlanders with kilts are to be seen, and much grumbling that it was no better than passing through the wheat lands of Norfolk or Suffolk. Arrive at North Berwick without seeing a single individual wearing a kilt. Boat to the Bass. Party land and scramble up the rock, but when they come to the ruins are stopped by a door at the top of a flight of steps. Door locked. Placard on it, containing, in large red letters, "Sold here—The Bass Rock." All think this very odd, but a learned person explains it to intimate that a book about the Bass Rock is to be sold. Still a curious thing that it should be sold at a door which is locked. Wait a long time at the door. Boat arrives, and man with a key. Takes 6d. each from all persons getting through—very neatly taken, as if he had practised at the gallery door of a theatre. Old gentleman with a large hammer laboriously but ineffectually battering away at the face of a protruding rock. Lady, anxious for geological information, ventures to ask what it is. Answer, "stone." Young members of the British Association communicate confidentially to each other, that they think they see symptoms of the upheaval of trap being traversed by a seam of amygdaloid, showing undoubted evidence of the igneous formation of the cavities filled by aqueous deposits. Discovery by young gent. of a valuable piece of bottle glass, indicating decided glacial scratches. Rumour that a black adder had been caught. General pressure towards the spot, but found that it was the dungeon in which Blackadder had been confined. Solan geese in a cleft of the rock—members of the British Association endeavour to hit them with stones. Solan geese show their estimation of the attempt by declining to budge. Reach a colony of the geese sitting at their ease in a corner. Goslings in round soft downy lumps. Young members walk up with great confidence to pick them up. Downy lumps protrude monstrous long black open bills, and make a ferocious outcry, so that young members make a hurried retreat. Ladies grumble that there is no botanical exhibition—nothing but weeds. Gentlemen pull mallow and seapink, demanding botanical explanation—nobody to give it. After a pleasant and funny ramble, swarm down to the boats. Deep green sea—calm—a pleasant west wind—the huge overtopping precipice black and white—the vessels lying in the creek—and the crowd winding down to them through the ruins, would make a nice picture. Boat-race. A dirty herring buss, with torn sail, carries it hollow against pleasure yacht and lighthouse cutters. A hat carried off by the wind—great general rejoicing expressed thereat. Gent. has his coat tails in the water. Great commotion begins in his pocket. Suddenly remembers that he has a packet of effervescing powders there. Finds that on getting wet the acids and the alkalies get into very bad terms with each other, and are on no account to be appeased—threaten to treat each other like the Kilkenny cats. Approach Tantallon. News that the great conglomerate will appear, and some people look out, as if they wondered why he didn't come. Scramble along the rock. Announcement of a trap dyke. Feeling prevalent that such a fence may be difficult to get over. Ruins of Tantallon. Cockneys demand a sight of the portcullis which Marmion let fall. Seem to be searching for it in the kitchens. Insist on seeing Queen Mary's apartment. Had always seen it hitherto in every castle they entered in Scotland. Inquiries if Macbeth and Robert the Bruce had ever lived here. Hot walk to North Berwick. As the programme had announced that the party would visit North Berwick Abbey, procession winds towards the ruins. Stout farmer and a body of hinds, drawn up across the road, dispute the passage. Embassy proceeds to overawe farmer, by stating that this is the British Association for the advancement of science. Farmer never heard of the Association—they are welcome to the advancement of science—but shan't advance into his fields. A council of war held, and British Association retreats before British farmer asserting the principle of protection. General demand at North Berwick Inn for needful sustentation. Innkeeper appalled by the arrival of 200 unexpected guests. Rush on the bakers and grocers in the village. Party determined to stick by the inn. Member of it searching in obscure corners finds a round of beef, and conveys it before his brethren to their great rejoicing. Fierce demand for drinking vessels. Committees prowl in the bedrooms, expecting to find jugs and tumblers, but all exhausted. A large portion of the party loud in praise of Mr. G. Girle, who not only lent his pleasure yacht, but freely bestowed his hospitality. Railway again. A train halts, which some of the party think must be the one to take them back. A few hanging like leeches to it as it starts. Railway officers find difficulty in peeling them safely off. Safe arrival at the North Bridge—the most remarkable phenomenon of the journey.—*Scotsman.*

ENGLISH PATENTS.

Sealed from 22d July, to 16th August, 1850.

Henry Bessemer, Baxter-house, Old St. Pancras-road, Middlesex, civil engineer,—"Certain improvements in figuring and ornamenting surfaces, and in the blocks, plates, rollers, implements, and machinery employed therein."—July 22d.

James Bradford, Torquay, Devonshire, jeweller,—"Improvements in locks and other fastenings."—22d.

Thomas Wills, Bow, Middlesex, engineer,—"Improvements in steam-engines and in pumps."—22d.

Joseph Paxton, Chatsworth, Derby, gentleman,—"Certain improvements in roofs."—22d.

Leonard Bower, Birmingham, Warwick, manufacturer, and Thomas Fortune, Harborne, Stafford, mechanic,—"Certain improved machinery for manufacturing screws, bolts, rivets, and nails."—23d.

William Beatson, Brick-lane, St. Luke's, Middlesex, brassfounder,—"Improvements in water-closets, pumps, and cocks."—23d.

William Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in obtaining, preparing, and applying zinc and other volatile metals, and in the oxides thereof; and in the application of zinc, or ores containing the same, to the preparation or manufacture of certain metals or alloys of metals."—(A communication.)—23d.

George Hazeldine, Lant-street, Southwark, Surrey, carriage-builder,—"Improvements in the construction of wagons, carts, and vans."—23d.

Henry Constantine Jennings, Great Tower-street, London, practical chemist,—"Improvements in rendering canvas, and other fabrics and leather, waterproof."—23d.

William Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in machinery for cutting files."—(A communication.)—23d.

George Dunbar, Esq., Paris,—"Improvements in suspending carriages."—23d.

Langston Scott, Moorgate-street, London, wine merchant,—"Improvements in a mode or modes of preparing certain matters or substances to be used as pigments."—24th.

Charles William Bell, Manchester, Lancaster,—"Improvements in apparatus connected with water-closets, drains, and cesspools, and gas and air traps."—25th.

Rodolphe Helbranner, Regent-street, Middlesex,—"Improvements in preventing the external air, and dust, and noise, from entering apartments."—31st.

Thomas Dickson Rotch, Drumlamford-house, Ayr, Esq.,—"An improved mode of manufacturing soap."—31st.

Matthew Trattles, Rochester, Kent, tool-maker,—"Certain improvements in saw-sets, mallets, and other tools, and in apparatus and machinery for manufacturing the same."—31st.

John Sheafe Gaskin, jun., island of Barbadoes, West Indies, gent.,—"Improvements in the manufacture of rum. To extend to the colonies only."—31st.

Richard Archibald Brooman, of the firm of J. C. Robertson & Co., 166 Fleet-street, London, patent agents,—"An improvement or improvements in abdominal supporters."—(A communication.)—31st.

James White, Holborn, Middlesex, mill-maker,—"Improvements in machinery for bruising, crushing, and for expressing juice from certain vegetable substances."—31st.

Henry Bessemer, Baxter-house, St. Pancras-road, Middlesex, engineer,—"Certain improvements in apparatus acting by centrifugal force in the manufacture of sugar, and other improvements in the treatment of saccharine matter by such apparatus."—31st.

Juan Nepomuceno Adorno, Golden-square, Middlesex, gentleman,—"Improvements in manufacturing cigars, and other similar articles."—31st.

Henry Rishton, Kendal, Westmoreland, plumber,—"Certain improvements in water-closets and urinals."—31st.

Joseph Poole Pirsson, civil engineer, New York,—"Certain improvements in steam machinery, and apparatus connected therewith."—31st.

John Hynam, Princes-square, Finsbury, Middlesex, chemical-light manufacturer,—"Improvements in machinery for placing splints of wood, and wax and composition tapers, in frames for dipping."—31st.

John James Greenough, George-street, Hanover-square, gentleman,—"Improvements in obtaining and applying motive power."—31st.

Peter Fairbairn, Leeds, York, machinist, and John Hetherington, Manchester,—"Certain improvements in machinery or apparatus for preparing, spinning, and weaving cotton, flax, and other fibrous substances; also, in constructing and applying models or patterns for moulding, preparatory to casting parts of machinery employed in preparing, spinning, and manufacturing fibrous substances; and also in certain tools to be used in making such machinery."—31st.

Matthew Gray, Morris-place, Glasgow, practical engineer,—"An improved method of supplying steam-boilers with water."—31st.

Edouard Gabriel Leroy, Paris, gentleman,—"Certain improvements in locomotive engines, and in the means and apparatus to be employed for generating and condensing the steam to be used therein."—31st.

Joseph Shaw, Paddock, near Huddersfield, York, cloth finisher,—"Improvements in constructing and working certain parts of railways."—August 3d.

John Gwynne, Lansdowne-lodge, Nottinghill, merchant,—"Improvements in obtaining motive power, and in applying the same to giving motion to machinery."—(Being a communication.)—5th.

Francis Kane, Berner's-mews, Middlesex, chair-maker,—"Improvements in reclining chairs, in castors for chairs and other articles of furniture, and improvements in presses."—5th.

William Crosskill, Beverley, York, civil engineer,—"Improvements in mills for grinding, splitting, pulverising, and crushing grain, bones, bark, ore, and other hard substances, and for grinding paint and other soft substances, and for shelling or removing the skin from rice and other grain, and in machinery for giving rotary motion to mills, thrashing machines, and any other machine requiring rotary motion, to be communicated by any horse or other animal."—(Being a communication.)—6th.

Joseph Steele, Chancery-lane,—"Improvements in coating and impregnating metals and metallic articles."—(Being a communication.)—9th.

Henry Meyer, Strand, Middlesex, gentleman,—"Certain improvements in power-looms for weaving."—10th.

Selim Richard St. Clair Massiah, Aldermen's-walk, New Broad-street, London,—"Improvements in the manufacture of artificial marble and stone, and in treating marble and stone."—10th.

Alfred Holl, Greenwich, Kent, engineer,—"Improvements in steam-engines."—12th.

Armand Nicolas Fréche, merchant, residing in Paris,—"Improvements in obtaiuing power."—12th.

Charles Cadby, Liquorpond-street, Middlesex, pianoforte-maker,—"Improvements in stringed musical instruments."—12th.

George Thompson, Park-road, Regent's-park, Middlesex, gentleman,—"Certain improvements in machinery and apparatus for cutting, digging, or turning up earth, applicable to agricultural purposes."—12th.

Samuel John Pittar, Church-place, Clapham, Surrey, civil engineer,—"Certain improvements in umbrellas and parasols."—13th.

Peter Claussen, Great Charlotte-street, Blackfriars, Surrey, manufacturer,—"Certain improvements in bleaching, and in the preparation of materials for spinning and felting, and in yarns and felts."—(Being a communication.)—16th.

William Keates, Liverpool, merchant,—"Improvements in machinery for manufacturing rollers and cylinders used for calico printing and other purposes."—16th.

SCOTCH PATENTS.

Sealed from 22d July, to 22d August, 1850.

Richard A. Brooman, Patent Office, 166 Fleet-street, London, patent agent,—"Improvements in types, stereotype plates, and other figured surfaces for printing from."—26th July.

Donald Beatson, Stepney, Middlesex, mariner,—"Certain improvements in instruments for taking, measuring, and completing angles."—29th.

Joel Spiller, Battersea, Surrey, engineer,—"Improvements in cleaning and grinding wheat and other grain."—29th.

William Edward Newton, Office for Patents, 66 Chancery-lane, Middlesex, civil engineer,—"Improvements in machinery or apparatus for making hat bodies, and other similar articles."—30th.

John Gwynne, Lansdowne Lodge, Nottinghill, merchant,—"Improvements in obtaining motive power, and in applying the same to giving motion to machinery."—31st.

Walter Neilson, Hyde Park-street, Glasgow, North Britain, engineer,—"Improvements in the application of steam for raising, lowering, moving, or transporting heavy bodies."—August 2d.

George Gwynne, Sussex-terrace, Middlesex, Esq.,—"Improvements in the manufacture of sugar."—7th.

William Cox, Manchester, Lancaster, cigar merchant,—"Improvements in machinery or apparatus for manufacturing aerated waters, or other such liquids."—(Communication.)—7th.

William Edward Newton, Office for Patents, 66 Chancery-lane, Middlesex, civil engineer,—"Improvements in obtaining, preparing, and applying zinc, and other volatile metals, and the oxides thereof, and in the application of zinc, and ores containing the same, to the preparation or manufacture of certain metals, or alloys of metals."—(Communication.)—8th.

Matthew Gray, 3 Morris-place, Glasgow, Lanark, practical engineer,—"An improved method of supplying steam-boilers with water."—9th.

William Watt, Glasgow, North Britain, manufacturing chemist,—"Certain improvements applicable to inland navigation, which improvements, or parts thereof, are also applicable generally to raising, lowering, or transporting heavy bodies."—13th.

George Augustus Huddart, Brynkir, Carnarvon, Esq.,—"Certain improvements in the manufacture of cigars."—14th.

James Rennie, Gowan Bank, Falkirk, Stirling, North Britain, gentleman,—"A certain improvement or improvements in the construction of gas retorts and furnaces, and in apparatus or machinery applicable to the same."—14th.

William Charles Bell, Manchester, Lancaster,—"Improvements in apparatus connected with water-closets, drains, and cesspools, and gas and air traps."—14th.

Henry Meyer, Strand, Middlesex, gentleman,—"Certain improvements in power-looms for weaving."—14th.

Read Holliday, Huddersfield,—"Improvements in lamps."—14th.

William MacNaught, Rochdale, Lancaster, engineer,—"Certain improvements in steam-engines, and also improvements in apparatus for ascertaining and registering the power of the same."—16th.

Alfred Holl, Greenwich, Kent,—"Improvements in steam-engines."—16th.

William Edward Newton, Office for Patents, 66 Chancery-lane, Middlesex, civil engineer,—"Improvements in the construction of ships or vessels, and in steam-engines, boilers, or generators."—(Communication.)—20th.

Edward Highton, Clarence Villa, Regent Park, Middlesex, engineer,—"Improvements in electric telegraphs, and in making telegraphic communications."—21st.

Charles William Lancaster, New Bond-street, Middlesex, gunmaker,—"Improvements in the construction of fire-arms, cannon, and projectiles, and in the manufacture of percussion tubes."—21st.

William Dick, Edinburgh, professor of veterinary medicine in the Edinburgh Veterinary College,—"Improvements in the manufacture of steel and gas."—22d.

IRISH PATENTS.

Sealed from 21st July, to 19th August, 1850.

Eugene Ablon, Panton-street, Haymarket, Middlesex,—"Improvements in increasing the draft in chimneys of locomotive and other engines."—31st July.

Joseph Barrans, St. Paul's, Deptford, Kent, Esq.,—"Improvements in axles and axle boxes of locomotive engines, and other railway carriages."—1st August.

Thomas Dickson Roteh, Drumlamford House, Ayr, Esq.,—"An improved mode of manufacturing soap."—1st.

Louis Napoleon Le Gras, Paris, France, civil engineer,—"Improvements in the separation and disinfection of fecal matters in the manufacture of manure, and in the apparatus employed therein."—3d.

Thomas Keely, Nottingham, manufacturer, and William Wilkinson, of the same place, framework knitter,—"Certain improvements in looped or elastic fabries, and in articles made therefrom; also certain machinery for producing the said improvements, which is applicable, in whole or in part, to the manufacture of looped fabries generally."—3d.

John Gwynne, Lansdowne Lodge, Nottinghill, merchant,—"Improvements in obtaining motive power, and in applying the same to giving motion to machinery."—6th.

George Augustus Huddart, Brynkir, Carnarvon, Esq.,—"Certain improvements in the manufacture of cigars, and certain apparatus for smoking certain cigars."—16th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 17th July, to 15th August, 1850.

July 17th,	No. 2380.	Arthur Samuel Hobson, Kew,—"Contracting and elongating parasol."
19th,	2381.	Charles Ledger, Sheffield,—"Table cutlery."
—	2382.	James Dannat, Bishop-Wearmouth,—"Domestic mangle."
—	2383.	Isaac and Campbell, St. James's Street, Pall Mall, and 71 High-street, Chatham,—"Barrack, college, and cabin portable furniture."
22d,	2384.	John Schofield, of the firm of Joshua and Christopher Schofield, and William Barker, millwright, in the employ of the said firm, Cornbrook, Hulme, Manchester,—"Face plate and cutters for rasping and chipping dyewoods."
—	2385.	William Randel, Birmingham,—"Hook and eye."
23d,	2386.	François Jules Livin Tige, Arthur-street West, London,—"Bath."
25th,	2387.	Ann Remington, Shaftesbury-crescent, Pimlico,—"Roasting apparatus."
26th,	2388.	John Wright, Sheffield,—"Tempering and straitening plates."
—	2389.	Andrew Campbell, Tottenham-court-road,—"Argyll bouquet-holder and watch protector."
27th,	2390.	Samuel Perkes, Birkenhead,—"Metallic folding bedstead."
—	2391.	George Boulton, Great Dover-street, Southwark,—"Crosha (or crochet) and tambour hook."
29th,	2392.	Henry Broadhead, Leeds,—"Flat whitening-brush."
30th,	2393.	Joseph Mackenzie, Bideford, Devon,—"'The Cheirosthenicon,'—an instrument calculated to give strength and flexibility to the fingers, and to communicate the equality of touch so essential to correct and brilliant execution on the pianoforte."
31st,	2394.	James Thornton and Sons, Birmingham,—"Signal-lamp."
Aug. 2d,	2395.	John Sanders, Birmingham,—"Set of dies for making pressed hinges."
—	2396.	William Palmer, Sutton-street, Clerkenwell,—"Candle-lamp."
3d,	2397.	John Goode, jun., Birmingham,—"Swivel."
—	2398.	William Palmer, Brighton,—"Sculptor's, statuary's, and modeller's revolving table."
6th,	2399.	John Martin, Killyleagh Mills, Down, Ireland,—"An arrangement of steam and water pipes to be applied in spinning flax, tow, and other fibrous substances."
7th,	2400.	Robert Davies, Globe-yard, South Molton-street,—"A pipe mount."
8th,	2401.	George Cart and Sons, Union-street, Southwark,—"Spring-folding collegian cap."
—	2402.	Joseph Welch and John Margetson, Cheapside,—"Folding trencher cap."
9th,	2403.	H. C. Windle, and W. D. Blyth, Walsall,—"Latch."
10th,	2404.	Susan Hooper and Co., Birmingham,—"Registered stove top."
12th,	2405.	Thomas and Charles Clark, Wolverhampton,—"Spring hinge."
13th,	2406.	Captain W. H. Armstrong, Cobham, Surrey,—"Rose-tree and flower girdle."
15th,	2407.	D. Y. Stewart and Co., St. Rollox, Glasgow,—"Core carriage."

TO READERS AND CORRESPONDENTS.

Books Received.—"On the Manufacture of Malleable Iron." By G. B. Thorneycroft. "The Commercial Hand-book of Chemical Analysis." By A. Normandy.

J. B., Montrose.—We have some particulars of the processes in view.

E. Swindon.—We suspect the authority to which he refers us—to he ratber out of date now. If we can procure authentic information on the several subjects, and including modern works, we shall certainly furnish it.

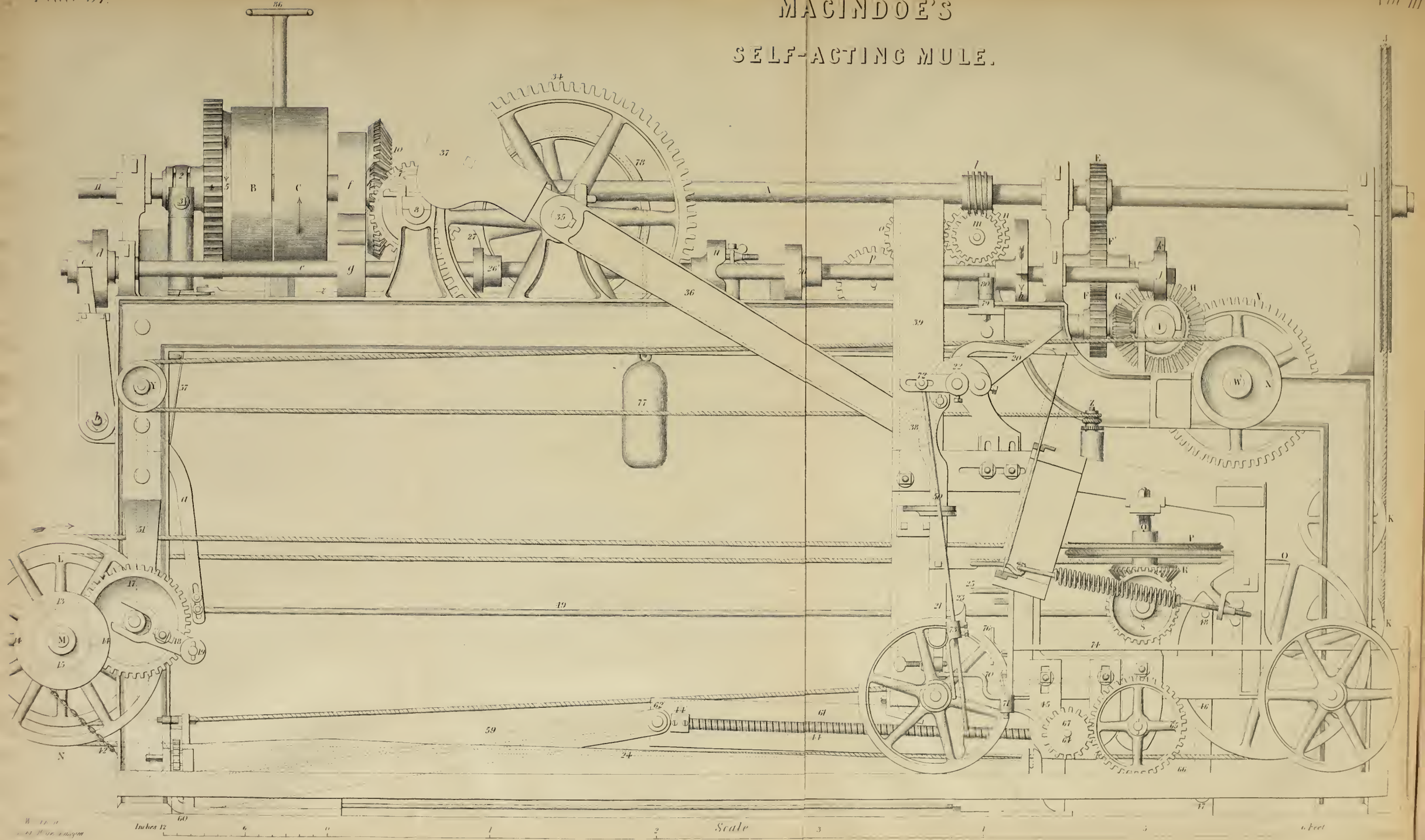
J. J., Leeds.—His polite favour was too late for the present issue. We shall make use of it in October.

Constant Reader, Leith.—The American spark-catcher has been frequently described. It would not do for our locomotives, burning coal.

Constant Reader, Hull.—We are obliged for his reminder. We have one of the examples in contemplation.

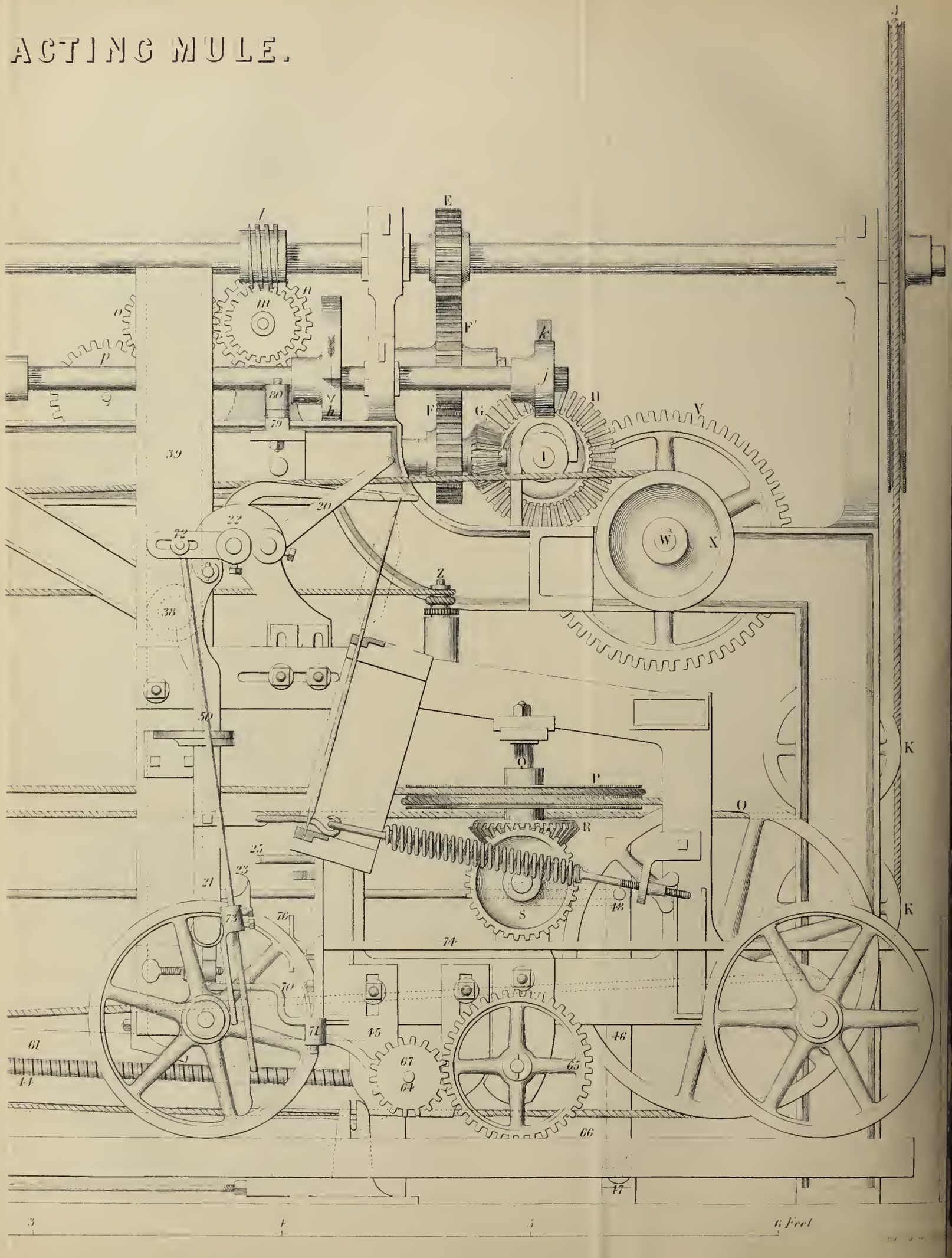
MACINDOE'S

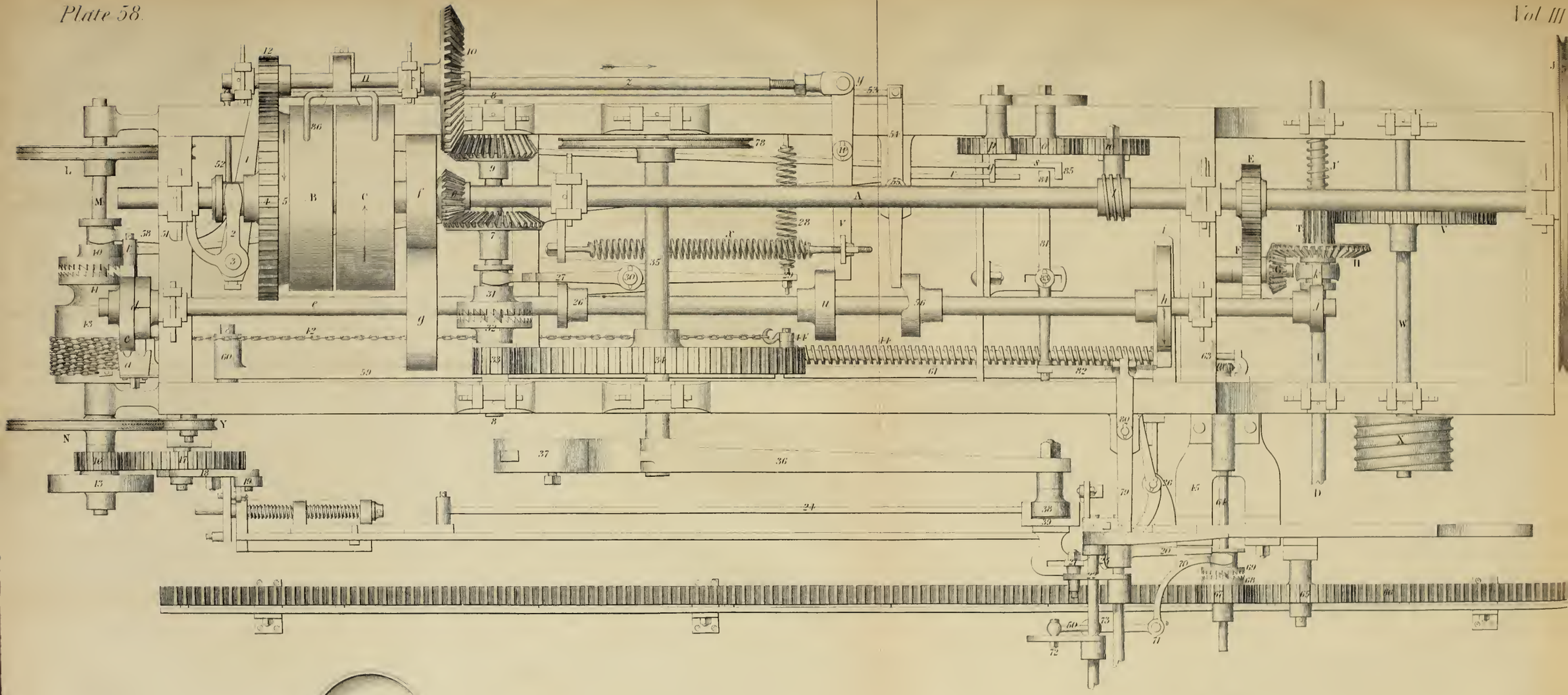
SELF-ACTING MULE.

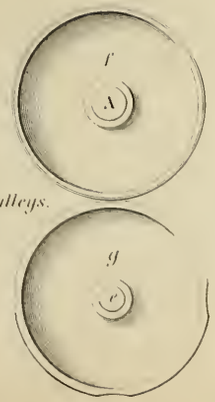


ACINDOE'S

ACTING MULE.



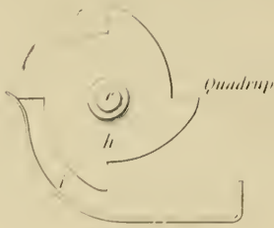




Disengaging Pulleys.

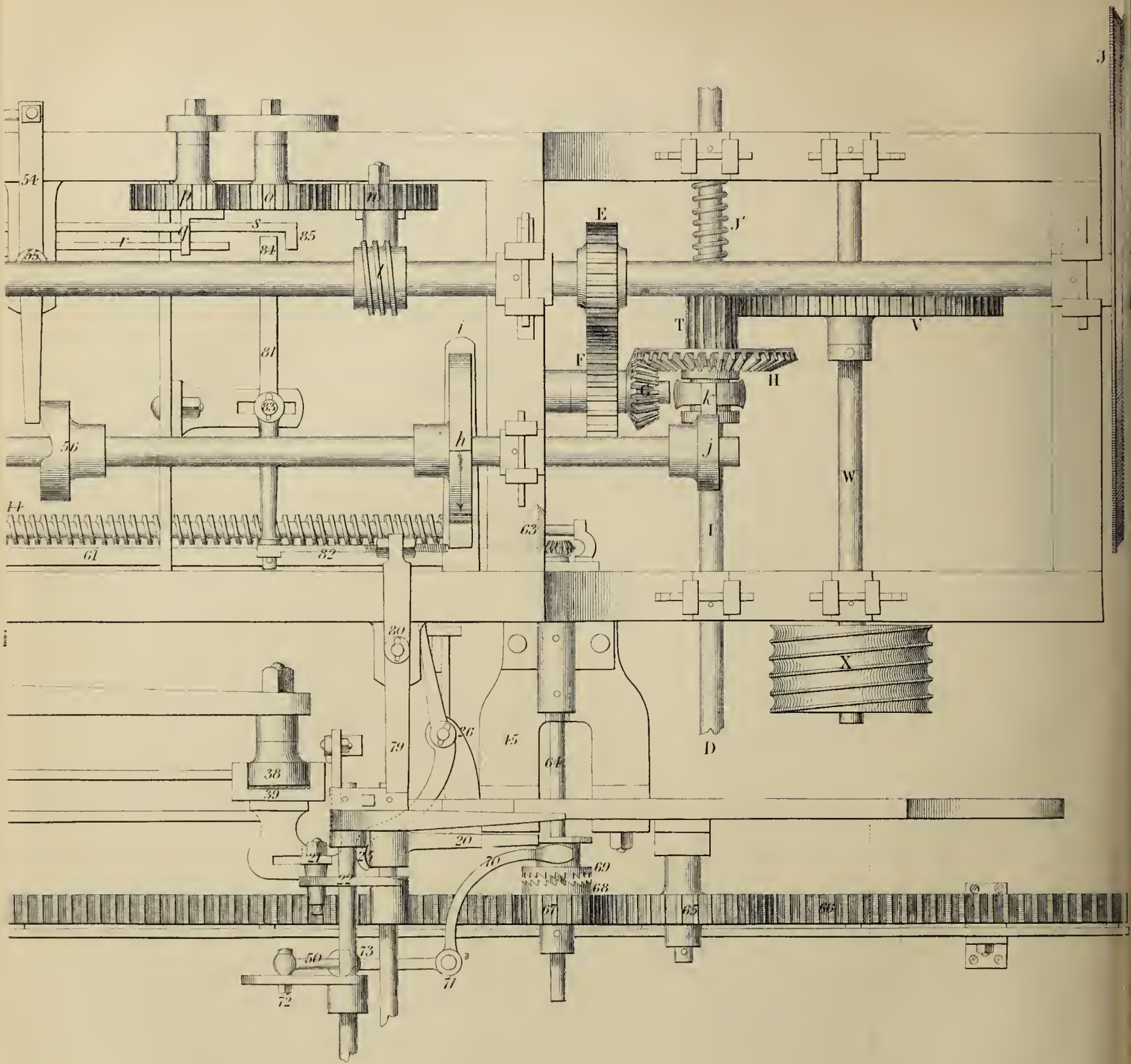
MACINDOE'S

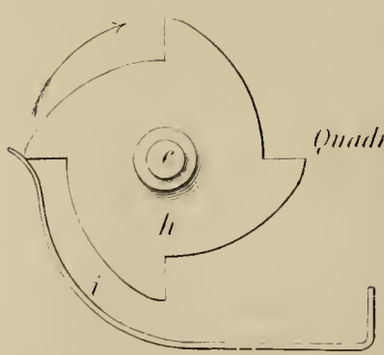
SELF-ACTING MULE.



Quadruple Cam.

Scale 6 Feet





Quadruple Cam.

S

ULE.

MACINDOE'S SELF-ACTING MULE.

(Illustrated by Plates 57 and 58.)

"If the thought should cross any mind, that, after all, the so much vaunted genius of our mechanics has been expended in the insignificant object of enabling men better to pick out, arrange, and twist together the fibres of a vegetable wool,—that it is for the performance of this minute operation that so many energies have been exhausted, so much capital employed, such stupendous structures reared, and so vast a population trained up: we reply—An object is not insignificant because the operation by which it is effected is *minute:* the first want of men in this life, after food, is *clothing*, and as *this* art enables them to supply it far more easily and cheaply than the old methods of manufacturing, and to bring cloths of great elegance and durability within the use of the humble classes, it is an art whose utility is inferior only to that of agriculture. It contributes directly, and most materially, to the comforts of life among all nations where manufactures exist, or to which the products of manufacturing industry are conveyed: it ministers to the comfort and decency of the poor, as well as to the taste and luxury of the rich. By supplying one of the great wants of life with a much less expenditure of labour than was formerly needed, it sets at liberty a larger proportion of the population to cultivate literature, science, and the fine arts. To this country the new inventions have brought a material accession of wealth and power. When it is also remembered, that the inventions are not confined in their application to one manufacture, however extensive, but that they have given nearly the same facilities to the woollen, the worsted, the linen, the stocking, and the lace manufactures, as to the cotton; and that they have spread from England to the whole of Europe, to America, and to parts of Africa and Asia; it must be admitted, that the mechanical improvements in the art of spinning have an importance which it is difficult to over estimate."—*Baines on the History of the Cotton Manufacture.*

The history of cotton-spinning tells us that, soon after the invention of the mule, which is more dependent on hand labour than any other producing machine in this manufacture, the importance of making it SELF-ACTING, forced itself on the attention of many, from motives of commercial enterprise, laudable competition, personal profit, and social advancement. It appears that the first self-acting mule was invented in 1790, by Mr. W. Strutt, of Derby, and the second by Mr. W. Kelly, of Lanark Mills, in 1792, but both were abandoned. About thirty-five years afterwards, two patents were granted on one day to two parties, for self-acting mules, one of which has been prosecuted with advantage to the patentee as well as the public. Since these were granted, about twenty others have been obtained for a like purpose, and their success has been as varied as their number. Cotton-spinners know well, that there is yet great necessity for improvement, and it will not create astonishment when we mention, that one party already alluded to, has been continuously improving the self-acting mule for twenty-five years.

To a mechanical mind, the object contemplated has many attractions. The machine in itself appears quite simple, yet the motions are complicated, requiring, at the same time, to be performed with mathematical precision. In perusing the various enrolled specifications of patented schemes of this class, we are struck with the wonderful amount and variety of invention as to the two principal movements; first, the taking in of the carriage, and second, the winding of the yarn on to the spindles to form the cop; and we now add a fresh example of what modern practice has contributed towards the improvement of these features, in the mule recently patented by Mr. George Park Macindoe, of this city.

We think we may reasonably claim for this mule a place alongside the highest perfections of the machinist's art, as well on the ground of the improvements which it offers in respect of the two points just alluded to, as on that of the simplicity and general efficieney of the entire combination. Every part is clearly seen, and easily accessible for adjustment—an eminently important advantage in the eyes of the manufacturer—for, in many mules, the mechanism is packed up into one corner, with the intention of exhibiting its excessively small bulk. But the intelligent cotton-spinner will not be fascinated with mere looks; and unless neatness can be associated with more essential considerations, let convenience alone be considered.

Mr. Macindoe's mule is simple enough to be easily understood by persons not particularly conversant with the nature of such machines, which is of no small moment, were it for no other reason than that a lower degree of mechanical ability in the spinning-master, as well as tenter, will suffice; and this, consequently, produces more independence on the part of the proprietor and employer. The mode of putting up the carriage is the most perfect hitherto invented, as it starts on its course inward with an almost imperceptible and steady motion, gradually increasing in speed until halfway—then more slowly, and arriving at the beam in the same progress as at its commencement. The carriage movement is from three to four seconds each stretch quicker than the class of mules having a mangle wheel, and it is not affected by any change which may be made on the mule to suit particular numbers. The steadiness of the motion renders squaring cylinders—which add greatly to the friction to be overcome, unnecessary—bands answering the purpose as well as in the hand-mule, and therefore, less power is necessary. The winding-on motion adopted is the most complete in use, being without friction, which requires constant watching, and is liable to rack as well as break the whole of the threads at any stretch, and so very ill adapted to the best qualities of yarn. The principle of stripping the yarn off the spindles, to allow the faller or guide to be depressed to form the cop, has always been considered unsuitable for the finer numbers, say above 50^{s} or 60^{s}—proving that a backing-off motion is indispensable for fine yarns. The backing-off in this mule will be found neat and efficacious, acting by wheels which are capable of the nicest regulation. Another motion of consequence in fine yarn is the second draw, and the one applied will be admitted to be equally sure and correct as in any hand-mule, and its velocity can be altered without changing the speed of any other part of the mule; whilst the manner in which the fallers are worked will be found simple, and not liable to derangement except through mismanagement.

Plate 57 represents a side elevation of the mule headstock, with a transverse section of the carriage as nearly run in. Plate 58 exhibits a corresponding plan of the mule-head, showing the end of the carriage next to it. The driving power is communicated to the machine through the horizontal first motion shaft, A, on which are the fast and loose strap pulleys, B, C. When the carriage is run in, up to the beam, or drawing-rollers, the front roller of which series is at D, the driving-strap is on the fast pulley, B, a portion of the strap's breadth being also on the loose pulley, C. Motion is communicated from the shaft A, to the drawing rollers by the spur-wheel, E, gearing with a second wheel, F′, loose on a stud, carried by the frame, and gearing with a second carrier wheel, F. This wheel carries with it a small bevel-wheel, G, driving the bevel-wheel, H, on the horizontal shaft, I, connected to the front line of drawing-rollers. The spindles are also driven from the shaft, A, by the cord pulley, J, on the inner extremity of the shaft. From this pulley an endless band passes downwards and beneath the guide pulleys, K K, and thence to the front pulley, L, fast on the horizontal shaft, M, the opposite end of which carries the pulley, N. A band from the latter pulley, passing round the stationary pulley, O, in the head, drives the double grooved pulley, P, on a short vertical shaft, Q, in the carriage. The same shaft carries the bevel-wheel, R, gearing with the second wheel, S, the horizontal shaft of which carries the drums, or the cylinder, whichever is used for driving the spindles. Whilst these movements for the spindles and drawing-rollers are going on, the small pinion, T, on the shaft, I, drives the spur-wheel, V, on the shaft, W, carrying on its projecting end a scroll pulley, X. This pulley has the end of a band attached to and wound upon it, the loose end being passed round the guide pulley, Y, and then turned back and attached to the carriage at Z, for the purpose of traversing it outwards as the yarn is being spun.

When the carriage arrives at the extent of its stretch, that is, at its furthest point from the drawing-rollers, a stud or catch attached to the carriage comes in contact with the tail of the lever, *a*, pushing it outwards, so that as it turns on its fixed centre at *b*, its upper end comes directly beneath the projection, *c*, of the cam, *d*, on the horizontal shaft, *e*, being regulated as to its length of movement by a notched or indented spring-catch on its end. This cam is formed with four projections diametrically opposite to each other in two different planes. When the lever, *a*, is moved, its end is relieved from a projection at the part marked, *d;* and the shaft, *e*, then being released, makes a quarter of a revolution, and is again stopped by the projection, *c*, coming down upon the end of the lever. The partial revolution of the shaft, *e*, is effected by the revolving pulley, *f*, fast on the boss of the loose pulley, C, on the first motion shaft. The periphery of the pulley, *f*, is covered with leather, so as to be capable of driving the corresponding pulley, *g*,

keyed on the cam shaft, *e*, which is extended to the front of the headstock so as to afford facilities for carrying the set of cams. Both these pulleys, *f* and *g*, are represented in elevation in the detail marked '*disengaging pulleys*,' in plate 58. The lower one, *g*, is recessed on its periphery in four places diametrically opposite to each other, so that when any one of these recesses is turned towards the pulley, *f*, the leather surface of the latter works free of it. The cam shaft, *e*, also carries a quadruple cam, or ratchet of four teeth, *h*, as represented in the detail marked '*quadruple cam*,' in plate 58. A flat spring, *i*, is screwed at one end to the frame, so that its opposite free end shall always press on one or other of the projections of the cam, *h*; thus tending to turn the cam round a short distance in the direction of the arrow—and consequently, when such a movement does take place, the recessed pulley, *g*, being keyed on the same shaft, receives the same movement. As the lever, *a*, is pushed back or forward from one plane of the cam, *d*, to the other, the cam shaft being released, is then turned slightly round by the spring action upon the cam, *h*, until the recess in the pulley, *g*, which is, at the time being, nearest to the centre of the pulley, *f*, is passed onwards, until the plain portion of the former pulley comes in contact with the periphery of the latter. The revolution of the pulley, *f*, then carries round the pulley, *g*, a quarter of a revolution, until the next of the four recesses comes forward to break the connection between the two pulleys.

As the carriage arrives at the extent of its stretch, the first movement performed by the cam shaft, *e*, actuated in the manner explained, is to throw the bevel-wheel, H, out of gear with the wheel, G, and thus stop the motion of the drawing rollers and carriage. This is accomplished by the cam, *j*, which in coming round presses against the projection on the upper end of the forked lever, *k*, working in a ring groove in the projecting boss of the wheel, H. This wheel slides loose on a feather in the shaft, I, and when otherwise unacted on, it is kept in gear with the wheel, G, by the pressure of the helical spring, *l*, which abuts at one end against the end-bearing of the shaft, the other end pressing against the outside of the boss of the spur pinion, T, placed loose on the shaft, immediately behind the bevel-wheel. The next operation is the stopping the motion of the spindles. This is effected by the worm, *l*, on the first motion shaft, A, gearing with the worm-wheel, *m*, keyed upon a short tubular shaft, carrying a spur-wheel, *n*, on its opposite end, and running loose on a short stud carried by the frame. The latter wheel again gears with the carrier-wheel, *o*, driving a similar wheel, *p*, both wheels running loose on studs carried by the frame. A pin, *q*, is attached to the face of the wheel, *p*, and as the latter makes one revolution during each stretch of the carriage, this pin is adjusted to act at the proper time upon the ends of the rods, *r* and *s*. The end of the rod, *r*, is notched to give a hold to the revolving pin, *q*, which thus pushes the rod longitudinally, the opposite end of the latter being jointed at *t*, to an upright lever on a short shaft carrying the lever, *a*, holding the cam, *d*. Thus, the action of the revolving pin, *q*, is to effect the change of position of the lever, *a*, as before noticed, permitting the pulley, *g*, with its shaft, *e*, to make a quarter of a revolution, bringing the cam, *u*, into action to effect the backing. This cam is notched on one side, as shown in the elevation, plate 57, and the quarter revolution just described, brings this notch opposite to the end of the lever, *v*, loose on a centre at *w*. When the end of the lever, *v*, falls into the notch into which it is pressed by the helical spring, *x*, the movement of the opposite end, *y*, of the lever, draws the rod, *z*, in the direction of the arrow. The other end of this rod is jointed to the end of the horizontal lever, 1, which is connected to the forked lever, 2, set on a centre at 3. The forked end of this lever fits to the grooved ring on the boss of the spur-wheel, 4, which is in one piece with the conical friction pulley, 5, and the latter is thus moved into frictional contact with the internal cone of the fast pulley, B, on the first motion shaft, A. The wheel, 4, with its external cone, 5, is made to revolve in the direction of the arrow, by the bevel-wheel, 6, on the first motion shaft, A, gearing with the wheel, 7, on the transverse shaft, 8. This shaft again carries a bevel-wheel, 9, gearing with the large wheel, 10, on the longitudinal shaft, 11, the opposite end of which shaft, carries a spur-pinion, 12, driving the wheel, 4, in a direction opposite to that of the first motion-shaft. Thus, when the cones are brought into action, the motion of the pulley, B, with its shaft, A, is reversed, and this change of movement reverses the motion of the spindles. So soon as the backing commences, the band-pulley, N, revolves in the direction of the arrow, carrying round with it on the same shaft the disc, 13, and some of the detents in which, 14, hold with the teeth of the ratchet-wheel, 15, carrying it round in the same direction. This ratchet-wheel is attached to the spur-wheel, 16, both running loose on their shaft; and the latter drives the wheel, 17, having screwed to one side of it, the adjustable lever, 18, carrying an anti-friction pulley, 19, on its free end. The upward movement of this lever then puts down the faller, 20, by elevating the pendant rod, 21, jointed at its upper end to the short lever, 22, working the faller. By the time the faller-wire has arrived at the level of the points of the cops, the foot of the rod, 21, is drawn upon the top of the catch, 23, resting on the shaper, 24. This movement of the rod, 21, then brings it against the end of the short lever, 25, set on a centre at 26. The opposite end of this lever comes in contact with the tail of the lever, *a*, shifting its upper end to the other plane of the catches—thus allowing the cam shaft to make a third quarter of a revolution. This movement then forces the end of the lever, *v*, out of the side notch of the cam, *u*, disengaging the cone, 5, from the pulley, B, and the movement of the cam, 26'; then releasing the forked lever, 27, the helical spring, 28, attached to the frame, pulls back the end, 29, of this lever, turning it upon its centre, 30, so as to force the sliding-clutch, 31, which is set on a fixed feather on the shaft, 8, into gear, with its loose counterpart, 32, on the same shaft. The spur-pinion, 33, is then carried round with its shaft, driving the large wheel, 34, keyed on the transverse shaft, 35. This shaft projects beyond the front of the framing, and carries the long oscillating, or vibrating lever, 36, the weight of the lower portion of which is counterbalanced by the weight, 37. The lower end of this lever carries an anti-friction pulley, 38, which is fitted to work in the vertical slot of the upright bar, 39, fast on the front end corner of the carriage; and thus a semi-revolution, or a portion thereof, of this radial arm, puts up the carriage in an expeditious and simple manner. At the same moment that the clutches, 31 and 32, are engaged, the clutches, 40 and 41, on the shaft, M, are also put in gear to wind on the yarn, by uncoiling the chain, 42, from the barrel, 43. One end of this chain is fast to the barrel, and being wound upon it, the loose end is attached to a hook, carried by the adjustable nut, 44', of the screw, 44, which is connected to the end of the carriage by the bracket, 45. Thus, as the carriage recedes from the chain-barrel, 43, during the putting-up movement, motion is communicated to the spindles by the band-pulley, N, carried on the shaft, M, along with the barrel, 43; which latter is caused to revolve by the carriage drawing off the chain.

When the carriage arrives at the beam, the bracket, 45, comes against the lower part of the upright lever, 46, which turns upon a fixed centre on the floor, at 47. This movement then forces back the lever, the upper end of which being jointed at 48, to the rod, 49, attached at the opposite end to the tail of the lever, *a*, draws back the latter, and shifts the catch-end to the other plane of the cam, *d*, allowing the shaft, *e*, to make its fourth quarter revolution, completing the series of movements of the cam apparatus. The last shift of the cam shaft disengages the two sets of clutches, 31 and 32, and 40 and 41, and sets the rod, 50, in readiness for another stretch. The clutches, 40 and 41, are worked from the upright shaft, 51, the head of which carries a bent lever, 52, jointed to the rod, 53, the opposite end of this rod being connected to the lever, 54, moving on a fixed centre at 55. This lever is worked by the notched cam, 56, which acts in a manner precisely similar to that of the cam, *u*, a spring being placed at 57, to press upon the bent lever arm for the return movement of the sliding-clutch, worked by the forked lever, 58, carried on the same upright shaft, 51.

In connection with the copping motion, a lever, 59, acting as a counterpart to the radial arm of the screw, 44, is jointed to a stud on the floor at 60. As the carriage recedes from the drawing-rollers, the outward movement of the radial arm, 61, causes a knee-joint action at 62, where the lever, 59, is connected, and the latter serves to carry up the radial arm, so as to make it assume a nearly vertical position, when the stretch is completed. The radial arm and screw action in self-acting mules, is of the ordinary kind, except in as far as regards the mode adopted for working the nut, 44', up the screw in the radial arm, as the diameter of the cop increases. When the building of the cop commences, the nut, 44', stands at the bottom of the screw, next the carriage. This extremity of the screw carries a bevel-pinion, 63, gearing with a similar pinion fast on the shaft, 64, working in a bearing in the bracket, 45,—a small spur-wheel, 65, runs loose on a stud in the headstock frame, and gears with the fixed rack, 66, on the floor, as also with the pinion, 67, loose on the shaft, 64, and carrying with it the loose clutch, 68. The counterpart of this clutch, 69, slides on a feather in the shaft, being worked by the curved end of the forked lever, 70, oscillating on a fixed stud centre, 71. The rod, 50, attached at 72, to the back lever of the counter-faller, carries a stud-piece, 73, in which is cut a diagonal slot, to allow the angular end of the forked lever, 70, to pass through it. With this arrangement, when the aggregate threads of yarn get too tight in winding on, the counter-faller is depressed, and the clutches, 68 and 69, are put into gear by their actuating lever, thus causing the revolution of the screw in the radial arm, by means of the bevel-pinions, 63, worked by the shaft, 64, to work the nut, 44', upwards, until the yarn is so much slackened as to permit the counter-faller to rise again, and disengage the clutches.

When the carriage arrives at the drawing-rollers, in the putting-up motion, the faller is disengaged by the sliding-rod, 74, which is carried

in guides in the carriage. This rod, coming in contact with the fixed upright, 75, its opposite end, 76, pushes against the end of the rod, 21, disengaging it from the piece, 23, when the faller rises by the downward tension and momentum of the rod. During the outward stretch of the carriage, the lever is returned outwards by the counter-weight, 77, which is hung to a chain passed over the pulley, 78, on the lever-shaft. When the carriage has been put up, and has arrived within two or three inches of the roller-beam, the upright slotted piece, 39, comes in contact with the lever, 79, moving on a centre at 80. The opposite end of this lever is jointed to the lever, 81, by the link, 82,—the lever, 81, moves on a centre at 83, and its contrary end, 84, hits the angular projection on the end of the rod, 85, and shifts the strap-fork, 86, to the fast pulley, B, for the commencement of a new stretch.

As a practical confirmation of the views which we have already expressed as to the efficiency of this machine, we have much pleasure in giving insertion to the following letter from Mr. John Erskine, the manager of the extensive cotton machine works of William Dunn, Esq.:—

GLASGOW, *Sept. 9th*, 1850.

Mr. George Park Macindoe.

Having been requested by you to give my opinion regarding your patent self-acting mule, I beg to say that its advantages and superiority consist in the following points:—

1st. The general arrangement is the best that I have seen—the different motions, distributed over the whole length of the head-stock, affording great convenience for inspection and adjustment.

2d. The backing-off motion being worked by wheels, can be regulated to any extent required by those in charge of the machine, and is altogether a first-rate movement.

3d. The putting-up motion for the carriage is very much in advance of anything hitherto attempted, whilst the additional produce of the mule, resulting from the backing-off and putting-up motions, will be fully 10 per cent. over mules with mangle wheels.

4th. The head-stock can be applied in the middle without cranks or connecting-rods and joints for connecting the guides, which is much superior to the old plan, and can be applied to hand-mules more easily than before, when the old carriages were used.

5th. The twist can be regulated just as in hand-mules—that is, with the same certainty; as also the drag on the carriage by wheels.

6th. The second draw is both simple and efficient, and admits of being driven at any desired velocity.

7th. The accuracy of all the movements is such as gives no trouble in the working of the mule.

Having enumerated a few points, I may say, in general terms that, for simplicity and efficiency, the mule is much a-head of any in this part of the country, and I have no doubt of its giving satisfaction to spinners.

(Signed) JOHN ERSKINE.

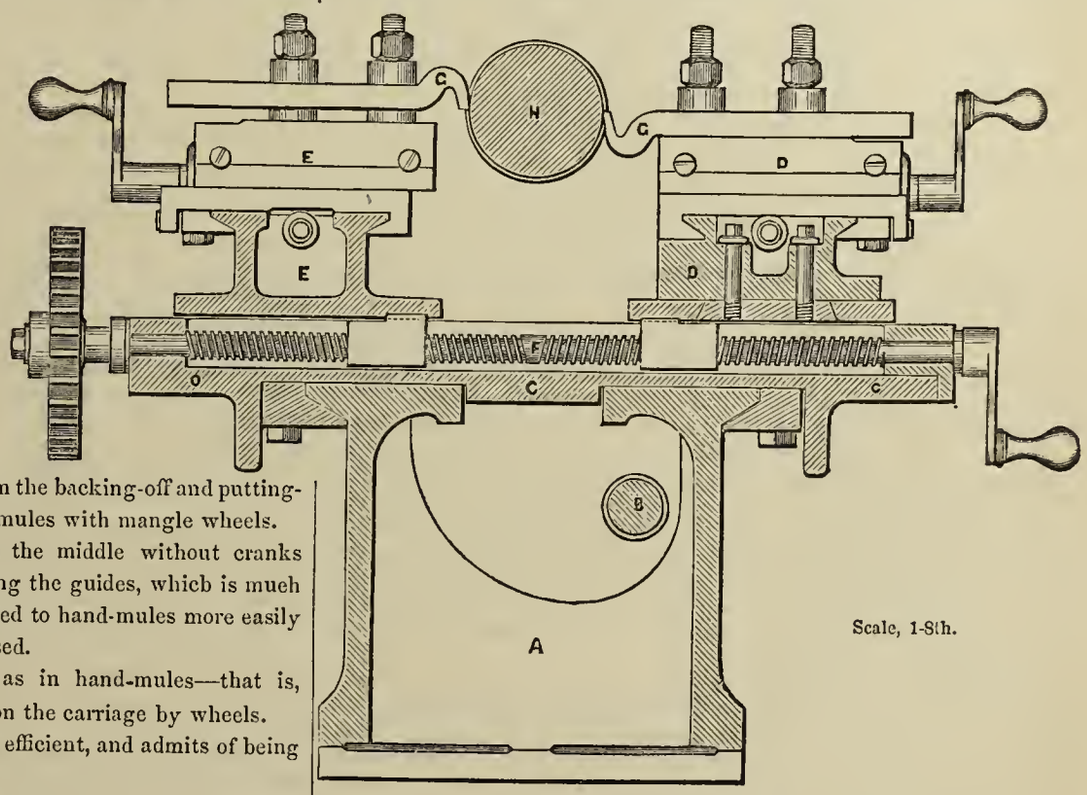
The clear detailed description of the various movements in this mule embodied in our foregoing remarks, leaves little room for explanatory observations, and we need do no more here than draw attention to the extreme elegance of the movement of the "disengaging pulleys." This arrangement is a perfect thing of its kind, and we foresee many uses to which it may be applied quite independent of its office in the self-acting mule.

WORKSHOP ECONOMICS—WHITWORTH'S DUPLEX LATHE.

We last month referred to this excellent contrivance, as having been brought before the Mechanical Section of the British Association, and we are now enabled to give a full detail of the precise arrangements from a drawing by the inventor. Our engraving represents a transverse section of the lathe-bed with the standards removed, with certain portions of the slide-rests also in section. A, Is the lathe-bed; B, is the guide-screw; and C, the bottom slide-rest or carriage, upon which is carried the compound top slide-rest, D, in front of the lathe. A corresponding compound top slide-rest, E, is similarly fitted on the back of the lathe, and it is this addition which constitutes the point of the invention. The two slides are moved simultaneously in and out by the right and left threaded screw-spindle, F, so that the back and front tools, G, are taken in and out of cut upon the work, H, simultaneously.

This arrangement is equally applicable for cylindrical or surface turning as for screw cutting. Of course, for surfacing, the two tools would stand at right angles to their present position, a self-acting motion being given to the right and left screw, F, in order to traverse the tools along their work. The top slide-rests are both provided with compound slides, whereby each tool may be adjusted to its work independently, and, when once adjusted, the right and left screw only is used.

Not only is double the work performed by this lathe, as compared with the common single-cut plan, but it is accomplished with a less expenditure of power, owing to the saving by the lessened pressure against the stay. The work is also executed in a superior manner, there being a perfect balance of forces, and, consequently, all vibration is done away with; and, from the greater durability of the tools so applied, only one-half the usual amount of error arises from wear.



Scale, 1-8th.

Five of these lathes are at work in Messrs. Whitworth's establishment in Manchester. They are turning out excellent work, at one-half the cost of that done by the common lathe—a sufficient recommendation, we presume, for a place in our chapters on "Workshop Economics."

Our readers will remember that a plan identical in principle has been applied and carried out by Mr. Findlay in his bobbin-turning machine, of which we gave a plate in our July part.

ON WEIGHT AND THE LAWS OF FALLING BODIES.

The bond which holds together the countless particles composing the universe, and orders them into their present arrangement and shape, is the power of attraction, or gravitation—a power which equally regulates the descent of the minutest grain of dust to the ground, and the motion of the planets in their orbits. The various particles of matter of the universe attract each other with a force which varies—

1. Directly as their masses: *e. g.*, if one of two bodies which are attracting each other has a mass twice, three times, or four times that of the other, then the attracting force of the former is twice, three times, or four times that of the latter.

2. Inversely as the square of their distances: *e. g.*, if a given distance be made two, three, or four times greater, the force of gravity will be four, nine, or sixteen times less.

Let M and m represent the masses, D and d the distances, and G and g the attracting forces of the two bodies; then, from (1) we have—

$$G : g :: M \cdot m, \text{ or } G = \frac{g\,M}{m}; \text{ and, if } g = 1, G = \frac{M}{m}.$$

From (2) $G : g :: d^2 : D^2$, or $G = g \cdot \frac{d^2}{D^2}$; and if $g = 1$, and $d = 1$, $G = \frac{1}{D^2}$.

From (1) and (2) $G : g :: M\,d^2 : m\,D^2$;

$$\text{Or } G = g \cdot \frac{M\,d^2}{m\,D^2}; \text{ whence, if } m = 1, \text{ and } d = 1, G = g \cdot \frac{m}{D^2}.$$

This is the general expression of the laws of gravity, M being taken to represent the attracting mass, and D the distance from another body on which it acts, as compared with the attracting force g of the second body, whose mass, = 1, and whose distance, = 1, are assumed as the units of measurement.

The attraction exerted by the earth is termed terrestrial gravitation; and since it is the combined operation of every part of the globe that produces it, we may consider the attracting force to act only from the centre. We must bear in mind that attraction does not reside only in this or that body, but that where A attracts B, B also attracts A, agreeably to the laws above explained. Therefore, when bodies are attracted towards the earth, they, in return, attract the earth towards them; but their masses being extremely small in comparison with the earth, the attraction which they exert is not measurably apparent. Gravity has the same intensity at all parts of the earth's surface which are at equal distances from the centre. As that point is approached, the intensity of gravity increases, and, as it is removed, the intensity diminishes, in accordance with the second law, above stated. Consequently, gravity is more intense at the surface of the ocean than at the top of a mountain—at the poles than at the equator

That which we call Weight is the effect of the gravitating force; it is the pressure which the attraction of the earth causes a body to exert upon some other body, interposed between it and the earth's centre. Weight is proportional to mass. *Absolute* weight is the relation which the pressure of a body bears to that of some other body, whose pressure is taken as unity. The body, or rather the amount of pressure, which is taken as the unity of admeasurement, varies in different countries. In Great Britain it is the pound, in France the gramme, &c. The absolute weight of bodies of similar constitution is proportional to their *volumes;* whilst bodies of dissimilar consitution have different absolute weights with equal volumes. Bodies which, with equal volumes, have different weights, have also different *densities;* that body which has the greater weight being more dense than another of the same volume, but of less weight.

By comparing the weight of any body with the weight of an equal volume of pure water, we obtain its *specific weight*, or *gravity*. Thus, the specific gravity of lead is 11·352, a number obtained by ascertaining the relative weights of a cubic inch, or a cubic foot, of the metal, and of water—the weight of the latter being taken as unity. The numbers show that lead is about 11⅓ times heavier than water.

The most palpable effect of the attracting force of the earth is seen in the fall towards it of bodies left without support. The direction of motion is towards the earth's centre. Since gravity acts with equal intensity on all bodies, each particle of matter being equally attracted by the earth; it follows, that all bodies should be seen to fall with the same velocity. But this seems to be contradicted by experience; every one knows that a piece of lead will reach the ground much more quickly than a flock of wool, when both are let fall at the same moment, from the same elevation. The resistance of the air, however, is the cause of this difference of speed, for, when that is removed, the lightest and heaviest substances fall at exactly the same rate. A metal coin and a feather are seen to descend alongside one another under an exhausted receiver.

A falling body has a motion uniformly accelerated—for the force which gave the motion a beginning is constantly acting upon it, and always with the same intensity; consequently, at every instant it adds a new degree of speed to that which it has already communicated, and the velocity, at the termination of its fall, is composed of all the small increments of velocity thus received added together. Hence, the greater the height of the fall, the greater the velocity at its termination.

In order the more clearly to understand what is meant by accelerated motion, and to comprehend the relation between the duration of the fall and the space passed through, let us divide the *time* which a body occupies in falling from a given height into any number of equal intervals. The rate at which it fell through any one of those intervals may be found by summing the rate of motion occasioned by the single influence of gravity acting with uniform intensity, and the rate at which it moved during the interval immediately preceding under the aggregate influence of the forces then impelling it. It is a law, that every body having acquired motion, will continue to move at precisely the same rate, until compelled to change that rate by some force external to it. In the case of falling bodies, it follows that the space traversed during any interval becomes greater as that interval is removed from the commencement of the descent; since, whatever speed the body may have acquired, it is continually accelerated by an additional increment of gravitating impulse.

On the other hand, if we divide the *space* through which a body falls in a given time into any number of equal intervals, then it will be found, that the time occupied in falling through any interval, is always less than that of the preceding, and greater than that of the following interval; and this is a consequence of the velocity being continually augmented.

It has been found, by experiment, that a body starting from a state of rest falls, when unimpeded by the air, in the latitude of Greenwich, through 16·095 feet during the first second of its descent, through 48·285 feet during the second second, through 80·475 during the third second, and through 112·665 feet during the fourth second.

Now, if we analyze the quantity of motion possessed by a falling body during any second of its descent, we shall find it composed of the velocity with which it entered into that second, and the velocity which it acquired during the same second. If it is the first second with which we are dealing, then, since it had no motion to begin with, and yet has run through a space of 16·095 feet during that second (in every division of which it moved faster than in the preceding division), we must assume the *mean velocity* of the body in that time to have been 16·095 feet, and its *final velocity* to be 32·190 feet; and we may conclude that if the gravitating force were now suspended, the body, if in vacuum, would fall through 32·190 feet in every subsequent second. If we direct our attention to the state of matters in the second second, we must take into account the velocity of 32·190 feet, with which it enters this second, and add to it the velocity of 16·095 feet, which it acquires by successive small increments in its descent. We thus find that it has a *mean velocity* of 48·285 feet during the second second. We must remember, however, that part of this motion (viz., that equal to 32·195 per second) existed independently of any motion communicated to the body during this second; and since it would have held on its course at this rate had it never received any further impulse, we may term this part of its motion *constant*. The other part of the motion—viz., 16·095 feet per second—was communicated by successive small increments, as in the case of 16·095 feet fallen through during the first second. Hence, the final velocity with which the body enters the third second, and with which it would continue to move through that and every subsequent second, were the force of gravity now removed, is 32·190 feet (velocity already acquired) plus 32·190 (the double of the mean velocity acquired during the second second) = 64·380 feet. A similar calculation for the following seconds will show that, although the velocity of a body, under the influence of gravity alone, is only 16·095 feet per second, yet that the space passed through in any second after the first is 32·190 feet more than the space passed through in the preceding second.

The following table will help to simplify the matter, and will show—

1st, That the final velocities increase as the times, or they follow in the order of the numbers 1, 2, 3, 4, &c.

2d, That the spaces passed through, in equal successive portions of time, increase as the odd numbers 1, 3, 5, 7, &c.

3d, That the total spaces fallen through, reckoning from the commencement of the fall, increase as the square of the times. Thus, 1^2, 2^2, 3^2, 4^2, &c. = 1, 4, 9, 16, &c.

To these may be added the law, that if the operation of the gravitating force were to be suspended after a body has been falling a given time, and the body were to continue in motion with the final velocity then acquired, it would descend with a uniform motion in a similar length of time through twice the distance it had previously traversed.

These laws are concisely expressed by the following formulæ—

$$v = gt \qquad s = \tfrac{1}{2}\,gt^2 = \tfrac{1}{2}\,vt,$$

where g represents the velocity acquired at the end of a second by the influence of gravity, or the double of the space fallen through in the same time; v the velocity acquired, and s the space fallen through at the end of t seconds:—

Seconds of Descent.	Space (in feet) fallen through in each successive second.	Total space (in feet) fallen through at the end of each second, reckoning from the commencement of the fall.	Ratio of the spaces fallen through during the successive seconds, with the space fallen through in the first second.	Ratio of the total space fallen through at the end of each second, with the space fallen through in the first second.
1	16·095	16·095	1	1
2	48·285	64·380	3	4
3	80·475	144·855	5	9
4	112·665	257·520	7	16
5	144·855	402·375	9	25
6	177·045	579·330	11	36
7	209·235	788·655	13	49
8	241·425	1029·180	15	64
9	273·515	1300·995	17	81
10	305·705	1609·500	19	100

When a body is placed upon an inclined plane, it will, of course, descend, and the motion will be a uniformly accelerated one; but since it cannot take the direction of gravity, its velocity will not he so great as that of a body falling freely. Part of the attracting force will be expended in the pressure upon the plane, whilst the rest produces the motion, the former being to the latter *as the base of the plane is to the length*. The accelerated motion of a body descending an inclined plane, or its relative force of gravity, is to that of a body falling freely *as the height of a plane is to its length;* and it acquires a final velocity, equal to that which it would have had, if it had fallen freely from the perpendicular height of the plane—whilst the space travelled through by a body falling freely, is to the space moved over on the inclined plane, in equal times, as the length of the plane is to its height.

When a body is projected in the direction of gravity, it will describe a path precisely the same as that it would have described if it had been falling freely; its motion will also be an accelerated one, and its velocity in each successive portion of time will be increased in proportion to the projectile force added to the gravitating force. For example, a body projected downwards, with the velocity, v, will fall in t seconds of space $= v\,t + g\,t^2$.

When a body is thrown vertically upwards, the influence of gravity will produce a *uniformly retarded* motion, until all the projectile force is expended. It will then fall vertically downwards, reaching the ground in exactly the same time that it occupied in going upwards, and acquiring the same velocity at the end of its fall, which it had when it was projected.

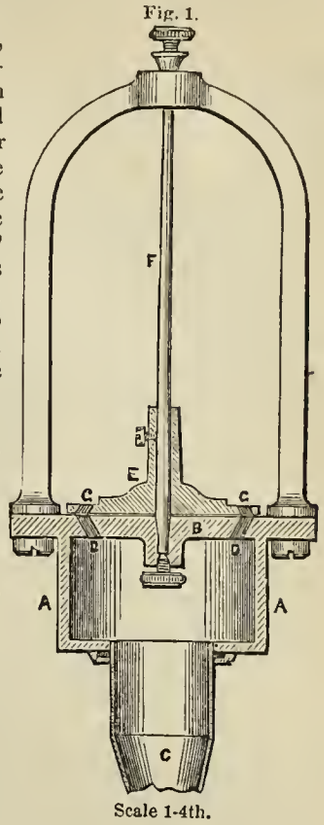
When the projectile force forms an angle with the gravitating force, the body to which these forces are applied will describe a path which is the resultant. On account of the unequal attraction of the earth, the body will describe, but for the resistance of the atmosphere, the curve called a parabola. In consequence of that resistance, however, it really describes the curve known to mathematicians as the *ballistic curve*. When a body is projected in a horizontal direction, its path will be represented by the half of a parabola, the vertex of which is at the point of projection. A body so projected moves in the direction of the projectile impulse, through a space equal to that which it would have described had it been subjected to that force alone; and it arrives at a point as much below that at which it began to move, as it would have reached had it fallen freely during the same time. Again, such a body descends towards the earth through the same space that it would have traversed had it been subjected only to the gravitating force during the time of its motion, inclining each moment from the original perpendicular, as far in the direction of the projectile force, as that force would have thrown it in the same time. Thirdly, a body projected in a horizontal direction reaches the earth in exactly the same time that it would have taken to fall freely from the same height.

ON THE SIRENE—A NEW SOUND PRODUCER.

By Prof. Donaldson, Edinburgh University.

In regard to the vibratory movement of fluid masses, it has long been known that when solid bodies are brought into collision under the water, the liquid is agitated directly in all the points where it touches the solid vibrating bodies—acquiring thereby an undulatory movement, producing sound, heard, of course, at a greater or lesser distance, corresponding to the violence of the shock. It is also known that, by a direct shock, the normal vibrations of discs, and longitudinal vibrations of rods, throw water, mercury, and other liquids, into an undulatory or vibratory motion; and it has, therefore, been very generally supposed, that the shock of solid bodies is essential to the production of an undulatory or vibratory movement in fluid masses. But the Baron de la Tour found that sounds could be produced under water without the percussion of fluid bodies, by throwing the water into rapid undulatory motion, by the play of the *sirene*, the instrument about to be described. The construction of this instrument, and the method employed, may, perhaps be more easily understood by an examination of the annexed figures.

Fig. 1.



Scale 1-4th.

Fig. 1, is a vertical section of a *sirene*, intended to act on the air. A, is a cylindrical brass-box, about two inches in diameter, and one inch in height, and having a closed top, B, about a quarter of an inch thick, with a perfectly plane upper surface, highly polished. In the bottom of this box is an opening for the introduction of the tube, or "*porte-vente*," C, by which wind is forced by bellows into the box. Openings, D, are pierced angularly through the top, B, as also represented in the plan of the top and revolving disc, in fig. 2, and in the side elevation of the same parts, fig. 3. These holes—16 in number—are disposed in a ring, and are equidistant from each other. They are each of the same size, and the spaces between them are slightly larger than the holes themselves, in order that when the revolving disc, E, is in motion, its corresponding ring of holes, G, may be quite cut off from any communication with the box, A.

The revolving disc, E, has a long boss upon its upper side for adjustment upon the vertical spindle, F, which has adjustable screw-centres at the top, in the upper part of the guide-frame, and at the bottom, in the box, A. The holes, G, in this disc, correspond in every respect with those in the top of the box, A, with the exception that they are pierced at an opposite angle, in order that the pressure of the upward currents or jets from the box beneath may cause the disc to revolve.* The two surfaces of the disc and top of the box are highly polished, and are so adjusted as to cause no perceptible friction, and yet to work close enough to prevent the escape of any air from between them. This is a very difficult matter to accomplish in practice, and the beauty and accuracy of the surfaces produced by the French makers of these instruments, is very remarkable.

Fig. 2.

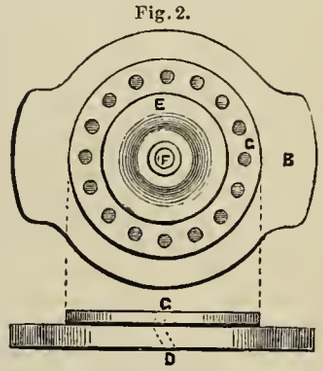


Fig. 3.

It is then easily seen how, when air is forced into the box, A, the jets issuing from the holes, D, impinging on the oblique surfaces of the corresponding holes in the disc, E, cause it to revolve at a rate proportioned to the pressure.

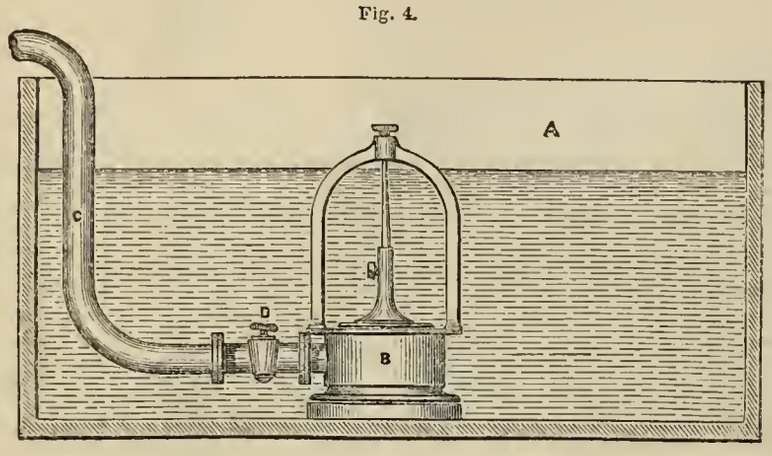
Now, let it be supposed that one hole only was pierced in the box, and one in the disc, the air, in its passage through the holes, would force round the disc, and during its revolution the wind *within* the box would be prevented from passing to the air *without* the box, until the hole in the disc came round to the hole in the box, when the wind would rush through as before, and thus keep up a regular rotatory motion, causing a stroke or pulsation on the atmosphere at each revolution. When these pulsations are perfectly regular, and attain to a rapidity of thirty-two in a second, a musical note will be obtained appreciable to most ears, although a very grave note. As the pulsations become more rapid, the note becomes more acute. The greater the number of holes the more rapid the pulsations.

This explanation will render it unnecessary for me to enter into further details, except to describe the plan I have adopted in using the *sirene* under water. A, is a large square cistern, the sides of which are of strong plate glass, and the bottom of mahogany, in a very strong frame. The *sirene*, B, made as already described, is firmly fastened down in the bottom of the cistern, a piece of caoutchouc being interposed between the surfaces to prevent the movement of the *sirene* from acting on the bottom of the cistern. The actuating water is brought by the gutta

* Strictly, the section, fig. 1, ought not to show any angularity in the holes, as the angle is in relation to the circumferential line of the disc, but they are so drawn to make the movement quite clear.—Ed. P. M. Journal.

percha tube, C, from a reservoir elevated about 30 feet above the cistern. The details of the instrument are analogous to those of the air

Fig. 4.



1-8th.

sirene, except that the water is brought into the box, B, by a side branch, governed by a stop-cock, D, and the holes in the box and disc are rather larger and fewer of them. On turning the cock, D, the water in the reservoir rushes into the cylindrical box, forces its way through the holes pierced in the upper part of the box at E E, which strikes those pierced in the disc, and thus keeps up a rotatory motion.

It must be observed, however, that unless the cistern is filled so as to completely cover the sirene, the water which is forced through the revolving disc will strike the *air;* for although it is a jet of water that is cut off by the rotation of the disc till the hole in the disc comes round towards the hole in the box, yet nevertheless it is the *atmosphere* which receives the shock or pulsation. But if the water completely covers the sirene, so as to be an inch or more above the revolving disc, then it is the water in the cistern which receives the shock or pulsation. The pressure of the water flowing from the reservoir causes the disc to revolve under water, and the small streams of water which are forced through the holes pierced in the box are cut off in their transit by the movement of the disc, until the holes in the disc corresponded to those in the box, when the water again rushes through and is again stopped, thus keeping up a continuance of regular alternations. The slight shocks or pulsations thus created in the water produce musical tones of singular purity, which become even purer and more and more sustained as the water flows into the cistern. It is also remarkable, that the gravest tones thus produced under water are far more readily appreciated, that is, recognised as musical, than tones produced by a similar number of vibrations in the atmosphere.

SIR DAVID BREWSTER'S ADDRESS TO THE BRITISH ASSOCIATION.*

TWENTIETH MEETING, EDINBURGH,

July 30, 1850.

From these brief notices of the progress of science, I must now call your attention to two important objects with which the British Association has been occupied since our last meeting. It has been long known, both from theory and in practice, that the imperfect transparency of the earth's atmosphere, and the unequal refraction which arises from differences of temperature, combine to set a limit to the use of high magnifying powers in our telescopes. Hitherto, however, the application of such high powers was checked by the imperfections of the instruments themselves; and it is only since the construction of Lord Rosse's telescope that astronomers have found that, in our damp and variable climate, it is only during a few days of the year that telescopes of such magnitude can use successfully the high magnifying powers which they are capable of bearing. Even in a cloudless sky, when the stars are sparkling in the firmament, the astronomer is baffled by influences which are invisible, and while new planets and new satellites are being discovered by instruments comparatively small, the gigantic Polyphemus lies slumbering in his cave, blinded by thermal currents, more irresistible than the firebrand of Ulysses. As the astronomer, however, cannot command a tempest to clear his atmosphere, nor a thunder storm to purify it, his only alternative is to remove his telescope to some southern climate, where no clouds disturb the serenity of the firmament, and no changes of temperature distract the emanations of the stars. A fact has been recently mentioned, which entitles us to anticipate great results from such a measure. The Marquis of Ormonde is said to have seen from Mount Etna, with his naked eye, the satellites of Jupiter. If this be true, what discoveries may we not expect, even in Europe, from a large reflector working above the grosser strata of our atmosphere! This noble experiment of sending a large reflector to a southern climate, has been but once made in the history of science. Sir John Herschel transported his telescopes and his family to the South of Africa, and during a voluntary exile of four years' duration he enriched astronomy with many splendid discoveries. Such a sacrifice, however, is not likely to be made again; and we must, therefore, look to the aid of Government for the realization of a project which every civilized people will applaud, and which, by adding to the conquests of science, will add to the glory of our country. At the Birmingham meeting of the Association, its attention was called to this subject, and being convinced that great advantages would accrue to science from the active use of a large reflecting telescope in the southern hemisphere, they resolved to petition Government for a grant of money for that purpose. The Royal Society readily agreed to second this application; and as no request from this Association has ever been refused, whatever Government was in power, we have every reason to expect a favourable answer to a memorial from the pen of Dr. Robinson, which has just been submitted to the Minister. A recent and noble act of liberality to science on the part of the Government justifies this expectation. It is, I believe, not yet generally known that Lord John Russell has granted £1000 a-year to the Royal Society for promoting scientific objects. The Council of that distinguished body has been very solicitous to make this grant effective in promoting scientific objects, and I am persuaded that the measures they have adopted are well fitted to justify the liberality of the Government. One of the most important of these has been to place £100 at the disposal of the committee of the Kew Observatory. This establishment, which has for several years been supported by the British Association, was given to us by the Government as a depository for our books and instruments, and as a locality well fitted for carrying on electrical, magnetical, and meteorological observations. During the last six years the Observatory has been under the honorary superintendence of Mr. Ronalds, who is well known to the scientific world for his ingenious photographic methods of constructing self-registering magnetical and meteorological apparatus. On the joint application of the Marquis of Northampton and Sir John Herschel, her Majesty's Government have granted to Mr. Ronalds a pecuniary recompense of £250 for these inventions; and I am glad to be able to state, that Mr. Brooke has also received from them a suitable reward for inventions of a similar kind. Under the fostering care of the British Association, the most valuable electrical observations have been made at Kew, and Mr. Ronalds has continued, from year to year, to make those improvements upon his apparatus which experience never fails to suggest;—but I regret to say that, in consequence of our diminished resources, the Association, at its meeting in 1848, came to the resolution of discontinuing the observations at Kew, appropriating at the same time, an adequate sum for completing those which were in progress, and for reducing and discussing the five years' electrical observations which had been published in our annual reports. I trust, however, that means will yet be found to maintain the Observatory in full activity, and carry out the original objects contemplated by the committee. Having had an opportunity of visiting this establishment a few weeks ago this summer, after having inspected two of the best conducted Observatories on the Continent where the same class of observations are made, I have no hesitation in speaking in the highest terms of the value of Mr. Ronalds' labours, and in recommending the institution which he so liberally superintends to the continued protection of the Association, and the continued liberality of the Royal Society. From the facts which I have already mentioned, and from many others to which I might have referred, the members of the Association will observe, with no common pleasure, that the government of this country has, during the last twenty years, been extending their patronage of science and the arts. That this change was effected by the interference of the British Association, and by the writings and personal exertions of its members, could, were it necessary, be easily proved. But though men of all shades of political feeling have applauded the growing wisdom and liberality of the state; and though various individuals are entitled to share in the applause, yet there is one statesman, alas! too early and too painfully torn from the affections of his country, whom the science of England must ever regard as its warmest friend and its greatest benefactor. To him we owe new institutions for advancing science, and new colleges for extending education; and had Providence

* Concluded from page 134.

permitted him to follow out, in the serene evening of life, and in the maturity of his powerful intellect, the views which he had cherished amid the distractions of political strife, he would have rivalled the Colbert of another age, and would have completed the systematic organization of science and literature and art, which has been the pride and the glory of another land. These are not the words of idle eulogy, or the expressions of a groundless expectation Sir Robert Peel had entertained the idea of attaching to the Royal Society a number of active members, who should devote themselves wholly to scientific pursuits; and I had the satisfaction of communicating to him, through a mutual friend, the remarkable fact, that I had found among the MSS. of Sir Isaac Newton, a written scheme of improving the Royal Society, precisely similar to that which he contemplated. Had this idea been realised, it would have been but the first instalment of a debt long due to science and the nation, and it would have fallen to the lot of some more fortunate statesman to achieve a glorious name by its complete discharge. It has always been one of the leading objects of the British Association, and it is now the only one of them which has not been wholly accomplished, "to obtain a more general attention to the objects of a science, and removal of any disadvantages of a public kind which impede its progress." Although this object is not very definitely expressed, yet Mr. Harcourt, in moving its adoption, included under it the revision of the law of patents, and the direct national encouragement of science, two subjects to which I shall briefly direct your attention. In 1831, when the Association commenced its labours, our patent laws were a blot on the legislation of Great Britain; and though some of their more obnoxious provisions have since that time been modified or removed, they are a blot still, less deep in its dye, but equally a stain upon the character of the nation. The protection which is given by statute to every other property in literature and the fine arts, is not accorded to property in scientific inventions and discoveries. A man of genius completes an invention, and after incurring great expense, and spending years of anxiety and labour, he is ready to give the benefit of it to the public. Perhaps it is an invention to save life—the life-boat; to shorten space and lengthen time—the railway; to guide the commerce of the world through the trackless ocean—the mariner's compass; to extend the industry, increase the power, and fill the coffers of the state—the steam-engine; to civilize our species, to raise it from the depths of ignorance and crime to knowledge and to virtue—the printing-press. But, whatever it may be, a grateful country has granted to the inventor the sole benefit of its use for fourteen years. But what the statute thus freely gives, law and custom as freely take away, or render void. Fees, varying from £200 to £500, are demanded from the inventor; and the gift thus so highly estimated by the giver bears the great seal of England. The inventor must now describe his invention with legal precision. If he errs in the slightest point—if his description is not sufficiently intelligible—if the smallest portion of his invention has been used before—or if he has incautiously allowed his secret to be made known to two, or even to one individual, he will lose in a court of law his money and his privilege. Should his patent escape unscathed from the fiery ordeal, it often happens that the patentee has not been remunerated during the fourteen years of his term. In this case the state is willing to extend his right for five or seven years more; but he can obtain this extension only by the expensive and uncertain process of an act of parliament; a boon which is seldom asked, and which, through rival influence, has often been withheld. Such was the patent law twenty years ago; but since that time it has received some important ameliorations; and though the British Association did not interfere as a body, yet some of its members applied energetically on the subject to some of the more influential individuals in Lord Grey's government, and the result of this was two acts of parliament, passed in 1835 and 1839, entitled "Acts for amending the law touching letters patent for inventions." Without referring to another important act, for registering designs, which had the effect of withdrawing from the grasp of the patent laws a great number of useful inventions, depending principally on form, I shall notice only the valuable provisions of the two acts above mentioned—acts which we owe solely to Lord Brougham. By the first of these acts the patentee is permitted to disclaim any part either of the title of his invention or of the specification of it, or to make any alteration on the title or specification. The same act gives the Privy Council the power of confirming any patent, or of granting a new one, when a patent had been taken out for an invention which the patentee believed to be new, but which was found to have been known before, but not publicly and generally used. By the same act, too, the power of letters patent was taken from parliament, and given to the Privy Council, who have, on different occasions, exercised it with judgment and discrimination. By the second act of 1839, this last privilege was made more attainable by the patentee. These are doubtless valuable improvements, which inventors will gratefully remember; but till the enormous fees which are still exacted are either partly or wholly abolished, and a real privilege given under the great seal, the genius of this country will never be able to compete with that of foreign lands, where patents are cheaply obtained and better protected. In proof of the justness of these views, it is gratifying to notice that, within these few days, it has been announced in parliament that the new Attorney-General has accepted his office on the express condition that the large fees which he derives from patents shall be subject to revision. The other object of the British Association mentioned by Mr. Harcourt, the organization of science as a national institution, is one of a higher order, and not limited to individual, or even to English interests. It concerns the civilized world; not confined to time, it concerns eternity. While the tongue of the Almighty, as Kepler expresses it, is speaking to us in his Word, his finger is writing to us in his works; and to acquire a knowledge of these works is an essential portion of the great duty of man. Truth secular cannot be separated from truth divine; and if a priesthood has in all ages been organized to track and exemplify the one, and to maintain, in ages of darkness and corruption, the vestal fire upon the sacred altar, shall not an intellectual priesthood be organized to develop the glorious truths which time and space embosom,—to cast the glance of reason into the dark interior of our globe, teeming with what was once life,—to make the dull eye of man sensitive to the planet which twinkles from afar, as well as to the luminary which shines above,—and to incorporate with our inner life those wonders of the external world which appeal with equal power to the affections and to the reason of immortal natures? If the God of Love is most appropriately worshipped in the Christian temple, the God of Nature may be equally honoured in the Temple of Science. Even from its lofty minarets the philosopher may summon the faithful to prayer; and the priest and the sage may exchange altars without the compromise of faith or of knowledge. Influenced, no doubt, by views like these, Mr. Harcourt has cited the opinions of a philosopher, whose memory is dear to Scotland, and whose judgment on any great question will be everywhere received with respect and attention; I refer to Professor Playfair, the distinguished successor, in our Metropolitan University, of the Gregories, the Maclaurins, and the Stewarts of former days; who in his able dissertation "On the Progress of the Mathematical and Physical Sciences," thus speaks of the National Institute of France:—

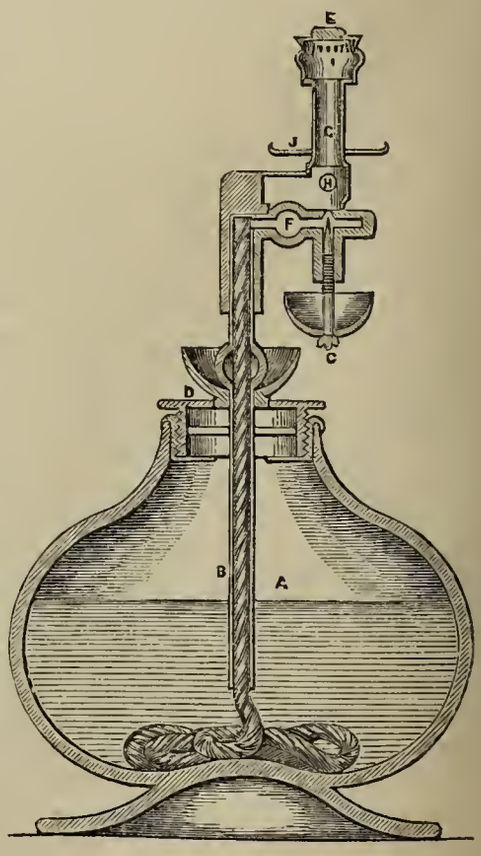
> "This institution has been of considerable advantage to science. To detach a number of ingenious men from everything but scientific pursuits—to deliver them alike from the embarrassments of poverty or the temptations of wealth—to give them a place and station in society the most respectable and independent, is to remove every impediment, and to add every stimulus to exertion. To this institution, accordingly, operating upon a people of great genius, and indefatigable activity of mind, we are to ascribe that superiority in the mathematical sciences which, in the last seventy years, has been so conspicuous."—Diss. 3d, sec. 5, p. 500.

This just eulogy on the National Institute of France, in reference to abstract mathematics, may be safely extended to every branch of theoretical and practical science; and I have no hesitation in saying, after having recently seen the Academy of Sciences at its weekly labours, that it is the noblest and most effective institution that ever was organized for the promotion of science. Owing to the prevalence of scientific knowledge among all classes of the French population, and to their admirable system of elementary instruction, the advancement of science, the diffusion of knowledge, and the extension of education, are objects dear to every class of the people. The soldier as well as the citizen—the Socialist, the Republican, and the Royalist—all look up to the National Institute as a mighty obelisk erected to science, to be respected and loved and defended by all. We have seen it standing unshaken and active amid all the revolutions and convulsions which have so long agitated that noble but distracted country—a common centre of affection, to which antagonist opinions, and rival interests, and dissevered hearts, have peacefully converged. It thus becomes an institution of order, calculated to send back to its contending friends a message of union and peace, and to replace in stable equilibrium the tottering institutions of the state. It was doubtless with views like these that the great Colbert established the Academy of Sciences in Paris, and that the powerful and sagacious monarchs on the continent of Europe have imitated his example. They have established in their respective capitals similar institutions—they have sustained them with liberal endowments—they have conferred rank and honours on their more eminent members, and there are now here present distinguished foreigners who have well earned the rewards and distinctions they have received. It is, therefore, gentlemen, no extravagant opinion that institutions which have thus thriven in other countries should thrive in ours—that insulated societies, which elsewhere flourish in combination, should, when combined, flourish among us—and that men ordained by the state to the undivided functions of science, should do more and better work than those who snatch an hour or two from their daily toil, or from their nightly rest. In a great nation like ours, where the higher interests and objects of the state are neces-

sarily organized, it is a singular anomaly that the intellectual interests of the country should, in a great measure, be left to voluntary support and individual zeal—an anomaly that could have arisen only from the supineness of ever-changing administrations, and from the intelligence and liberality of a commercial people—an anomaly, too, that could have been continued only by the excellence of the institutions they have established. In the history of no civilized people can we find private establishments so generously fostered, so energetically conducted, and so successful in their objects, as the Royal Societies of London, Edinburgh, and Dublin, and the Astronomical, Geological, Zoological, and Linnæan Societies of the metropolis. They are an honour to the nation, and will ever be gratefully remembered in the history of science. But they are, nevertheless, defective in their constitution, limited in their operation, and incapable, from their very nature, of developing, and directing, and rewarding the indigenous talent of the country. They are simply subscription societies, which pay for the publication of their own transactions, and adjudicate medals entrusted to them by the beneficence of others. They are not bound to the exercise of any other function, and they are under no obligation to do the scientific work of the state, or to promote any of those national objects which are entrusted to the organized institutions of other lands. Their president and council are necessarily resident in London; and the talent and genius of the provinces are excluded from their administration. From this remark we must except the distinguished philosophers of Cambridge and Oxford, who, from their proximity to the capital, have been the brightest ornaments of our metropolitan institutions, and without whose aid they never could have attained their present pre-eminence. It is, therefore, in the more remote parts of the empire that the influence of a national institution would be more immediately felt, and nowhere more powerfully than in this its northern portion. Our English friends are, we believe, little aware of the obstructions which oppose the progress of science in Scotland. In our five universities there is not a single fellowship to stimulate the genius and rouse the ambition of the student. The church, the law, and the medical profession hold out no rewards to the cultivators of mathematical and physical science; and were a youthful Newton or Laplace to issue from any of our universities, his best friends would advise him to renounce the divine gift, and to seek in professional toil the well-earned competency which can alone secure him a just position in the social scale, and an enviable felicity in the domestic circle. Did this truth require any evidence in its support, we find it in the notorious fact that our colleges cannot furnish professors to fill their own important offices; and the time is not distant when all our chairs in mathematics, natural philosophy, and even natural history, will be occupied by professors educated in the English universities. But were a Royal Academy or Institute, like that of France, established on the basis of our existing institutions, and a class of resident members enabled to devote themselves wholly to science, the youth of Scotland would instantly start for the prize, and would speedily achieve their full share in the liberality of the state. Our universities would then breathe a more vital air. Our science would put forth new energies, and our literature might rise to the high level at which it stands in our sister land. But it is to the nation that the greatest advantages would accrue. With gigantic manufacturing establishments, depending for their perfection and success on mechanics and chemistry; with a royal and commercial marine almost covering the ocean; with steam-ships on every sea; with a system of agriculture leaning upon science as its mainstay; with a network of railways demanding for their improvement, and for the safety of the traveller, and for the remuneration of their public-spirited projectors, the highest efforts of mechanical skill, the time has now arrived for summoning to the service of the state all the theoretical and practical wisdom of the country; for rousing what is dormant, combining what is insulated, and uniting in one grand institution the living talent which is in active but undirected and unsupported exercise around us. In thus pleading for the most important of the objects of the British Association, I feel that I am not pleading for a cause that is hopeless. The change has not only commenced, but has made considerable progress. Our scientific institutions have already, to a certain extent, become national ones. Apartments belonging to the nation have been liberally granted to them. Royal medals have been founded, and large sums from the public purse devoted to the objects which they contemplate. The Museum of Economic Geology, indeed, is itself a complete section of a Royal Institute, giving a scientific position to six eminent philosophers, all of whom are distinguished members of this Association. And in every branch of science and literature the liberality of the Crown has been extended to numerous individuals, whose names would have been enrolled among the Members of a National Institution. The cause, therefore, is far advanced; and every act of liberality to eminent men, and every grant of money for scientific and literary purposes, is a distinct step towards its triumph. Our private institutions have, in reality, assumed the transition phase, and it requires only an electric spark from a sagacious and patriotic statesman to combine in one noble phalanx the scattered elements of our intellectual greatness, and guide to lofty achievements and glorious triumphs the talents and genius of the nation. But when such an institution has been completed, the duties of the State to science are not exhausted. It has appreciated knowledge, but in its abstract and utilitarian phase. It would be of little avail to the peace and happiness of society if the great truths of the material world were confined to the educated and the wise. The organization of science thus limited would cease to be a blessing. Knowledge secular and knowledge divine, the double current of the intellectual life-blood of man, must not merely descend through the great arteries of the social frame. It must be taken up by the minutest capillaries before it can nourish and purify society. Knowledge is at once the manna and the medicine of our moral being. When crime is the bane, knowledge is the antidote. Society may escape from the pestilence and may survive the famine, but the demon of ignorance, with his grim adjutants of vice and riot, will pursue her into her most peaceful haunts, destroying our institutions, and converting into a wilderness the paradise of social and domestic life. The State has, therefore, a great duty to perform. As it punishes crime, it is bound to prevent it. As it subjects us to laws, it must teach us to read them; and while it thus teaches, it must teach also the ennobling truths which display the power and the wisdom of the great Lawgiver, thus diffusing knowledge while it is extending education; and thus making men contented, and happy, and humble, while it makes them quiet and obedient subjects. It is a great problem yet to be solved to determine what will be the state of society when man's physical powers are highly exalted, and his physical condition highly ameliorated, without any corresponding change in his moral habits and position. There is much reason to fear that every great advance in material civilization requires some moral and compensatory antagonism; but however this may be, the very indeterminate character of the problem is a warning to the rulers of nations to prepare for the contingency by a system of national instruction, which shall either reconcile or disregard those hostile influences under which the people are now perishing for lack of knowledge.

HOLLIDAY'S SELF-GENERATING GAS LAMP.

Since our earlier notices of this invention,* Mr. Holliday has patented and introduced several modifications of his original plan, which deserve, at least, a passing notice amongst the novelties of the time.



In place of being above the light, as delineated in the drawing of the lamp which we have already given, the reservoir, or fountain of naphtha, is placed below, and it is therefore more conveniently arranged for the table; and the centre of gravity being lowered, there is less danger of overturning. The figure annexed, represents the pedestal, or table lamp, in vertical section. The spirit is contained in the bottom reservoir, A, forming the base—into which a tube, B, carrying a wick, is caused to dip for the capillary attraction, or lifting of the oil to the burner, on the top of the tube, C. To prevent the conduction of heat from the burner down to the reservoir, a disc, or plate, D, is attached to the tube, B, to enable the latter to be fixed up with some non-conducting material; and as the plate screws off, it affords facilities for the supply of the reservoir. The burner is at E, and the gas-

* Pages 180, vol. i., and 110, vol. ii.

producing spirit passing up the fibres of the cotton in the tube, B, is regulated in its upward flow by the stop-cock, F. After passing this point, the spirit having become vaporized by the conducted heat of the burner, passes through a conical aperture, adjustable by a small conical-ended spindle, G, which is screwed up or down from below. Above this the vapour meets and mingles with the air, admitted by two opposite openings at H, and the gaseous product then rushes upwards against the top of the burner, and, being thus deflected horizontally, it issues at the ring of apertures, I, where it is burnt in a series of jets.

The burner has a gallery at J, for carrying a glass, and an external air-cover with an adjustable tube, for regulating the admission of air by the holes, H. Amongst other details, the patentee has specified a burner, made entirely of cast metal, and without any internal tube.

SCIENTIFIC NOTES, PRINCIPALLY FOREIGN.

THE MANUFACTURE OF SUGAR—SALT IN AGRICULTURE—LIQUEFACTION OF THE GASES BY A NEW METHOD—VELOCITY OF LIGHT.

The Manufacture of Sugar, has of late been a matter to which much attention has been directed, and the processes connected with this branch of industry have recently been very considerably simplified. It is known that the cane and the beet-root contain a sweet juice, which is extracted from the first by crushing it, and from the second by rasping it and then submitting it to pressure. The solid residue still retains some sugar, so much so that it affords a nutritious diet for cattle. The expressed juice is a liquid, containing besides sugar, several other matters difficult to separate from it, which tend to decompose the sugar. It is with the view of finding some ready means of getting rid of these useless or noxious bodies, that most of the recent experiments have been made.

M. Mége, a French chemist, has made use of sulphuric acid to destroy the azotised matter, which tends to transform sugar into alcohol, and into lactic, butyric, and other acids. This process yields a limpid and colourless juice, but it is attended with the risk of injuring the saccharine matter. Another chemist of the same nation, M. Melfens, employs sulphurous acid, which clarifies the juice, prevents fermentation, and renders refinement unnecessary previous to the making it into loaves. This plan has the advantage of economy; but there is a suspicion that the acid acts upon the saccharine matter, reduces the quantity, and is injurious to the quality. Messrs. Oxland, of Plymouth, with the same object in view, have used a solution of acetate of alumina. When the defecation has been effected by means of this salt, it is precipitated by a small quantity of tannin, and the free acid by carbonate of lime.

The means hitherto employed to effect the separation of the fermenting matters were to add lime; but it is not easy to discover, accurately, the quantity exactly sufficient for the purpose, and an excess colours the syrup, renders it viscid, besides being attended with other disadvantages. Reagents may be employed to remove the lime, but M. Kuhlmann prefers carbonic acid. When the syrup has been made to evaporate to the point of crystallization it is allowed to stand, and then different mechanical contrivances are employed to withdraw the crystals from the viscid matter, known as molasses or treacle, which will not crystallize. The too great proportion of this article is not desirable, and with the view of turning it to profitable account, several chemists have tried various experiments with more or less success. Some of them heat the molasses with the sulphuret of barium; the compound is, in a great measure, insoluble; it is washed, and the barytes removed by sulphuric or carbonic acid. Scoffern's process is applied to the operation of refining. Acetate of lead (sugar of lead), is employed to purify the sugar, and this salt completely separates all the foreign organic matters: to remove all traces of the lead the syrup is treated with sulphurous acid. Ingenious as this process is, there is some risk that the acetate of lead (a dangerous poison, as is well known) is not entirely removed, and it is the more difficult to be satisfied on this point as the salt is itself sweet. Such are the various methods in course of being tested; time will show which best answers the intended purposes.

Salt in Agriculture.—The extensive salt mines of England afford such an abundant supply of this article, that it is much cheaper among us than among most European nations; and we have been able to make various experiments with it on a large scale, particularly with reference to its value as a manure. Notwithstanding the common notion that it is a useful fertiliser of the soil, there does not really seem to be any data for such an opinion; nor does there appear to be any ground, in fact, to suppose that it acts usefully in the fattening of animals.

Liquefaction of the gases by a new method.—M. Berthelot, a French chemist, has conceived a simple and ingenious process to demonstrate the liquefaction of gases. He takes a very thick barometrical tube, open at one end only, and this is filled with mercury. The tube, when filled is placed horizontally in a water-bath, and its open end is connected with another tube placed in communication with an apparatus which generates the gas intended to be liquefied. The tube of mercury is then heated; the metal dilates, and part of it runs out of the tube. When it has acquired the temperature of 122° Fahr., it is subjected to it for some time, and then left to cool. The mercury contracts, and the space occupied by the metal which escaped is filled with the gas; when it is completely cold, the tube is detached from the rest of the apparatus, and the open end closed by heat. Entire success has attended the experiment when carbonic acid gas was used. In order to produce liquefaction, the tube is heated in the water bath to the temperature of 137° to 139°. The dilating mercury compresses the gas, and soon reduces it to a liquid; as the temperature is lowered, it resumes its gaseous condition. This process has not succeeded with oxygen, hydrogen, the oxide of carbon, the bioxide of azote, and other gases, on account of the tubes employed not being strong enough to resist the requisite pressure.

Velocity of Light.—We are sometimes astonished at the nearly simultaneous appearance of several discoveries of the same thing, and it has been the custom to account for the fact by supposing that there had been some secret disclosures, some betrayal of confidence, that justified the mystery with which, in the middle ages, it was usual to envelop inquiries of this kind. But would it not be nearer the mark to seek for this simultaneousness in the wide currency of the same general ideas? In the progress of events, certain things are felt to be more and more desirable, their absence becomes more and more inconvenient, the attention of many persons becomes directed to the same subject, one notion begets another, until the moment arrives when the complete idea issues into light, and half a dozen minds lay claim to the parentage. Such may be taken to be the history of the maritime discoveries of the 16th century—of the invention of the telescope, which several nations lay claim to—of the discovery of oxygen, of photometry, &c. One of these disputed claims was that relating to illumination by means of electricity, in France, where two competitors have offered themselves only last year, nearly at the same moment. One was M. Foucault, a skilful and ingenious physicist, in whose hands the theory of light has made a marked progress. The other was M. Fizeau, who being on the same track, has grappled with some facts which, if we cannot award them the palm of throwing new light on the subject, have at least the merit of yielding a new and authentic confirmation to the discoveries of Foucault. Their experiments go far to remove doubt upon one very important question, and we shall devote a few words to an explanation of its importance and difficulty.

Two theories have sought to explain the phenomena of light—the theory of emission, and the theory of undulations. The first, which originated with Newton, consists in regarding light as a *body* thrown into space by the sun, the stars, and other self-luminous bodies, and moving with immense rapidity. In the second theory, which was first promulgated by Descartes, all space is supposed to be filled with a fluid of extreme subtlety, to which the name of ether has been given. This fluid is set in motion by light in the same manner as a sonorous body causes to vibrate those portions of air which are in contact with it, and which, when vibrating, produce in our ears, the organs specially designed to be thus affected, the sensation of sound.

The principal phenomena of light, its reflection from polished surfaces, its refraction—that is, the deviations it makes when passing through media of varying density—its decomposition into coloured parts by means of a prism of glass, all these are well enough explained by the Newtonian theory. However, there are objections of serious moment to this theory, in the shape of difficulties which it is not able to solve: for example, the force with which light is emitted should be proportional to the mass of the luminous body and to that of the body on which it is incident, or rather, which attracts it; yet experience proves that its velocity is ever the same, whatever be its source, and whether it be direct reflected or refracted. By this theory it is not explained, except by a dubious hypothesis, how part of an incident ray is reflected and the other refracted. In the other theory, however, these questions present no difficulty. Although the ether, the subtle fluid the vibrations whereof cause all luminous effects, has not been directly produced to our senses, yet its properties have been the subject of minute and delicate calculations. To give an idea of the rapidity of its motion, we may state that 564,000 vibrations, on an average, take place in the millionth part of a second. Now these vibrations are not made in the direction of the path traversed by a ray of light, but in a direction perpendicular to that path. Therefore, whatever be the elasticity of the ether, and the facility with which light is propagated through it, it is evident that the velocity of its motion must experience a certain modification according to the density of the media in which it occurs. Such is the capital question which must

finally decide the truth of one or other theory, and we now proceed to detail the beautiful experiments by which it has been decided.

These experiments start from a principle enunciated several years since by a kind of prevision by M. Arago. The advocates of the emission theory explained the change of direction undergone by light in the phenomenon of refraction only by an acceleration of velocity in the luminous matter when traversing a denser medium. But the contrary ought to take place if we take the guidance of the other theory, and it struck the philosopher that Professor Wheatstone's revolving mirror apparatus might be usefully employed in making an experiment which should test the matter. To evolve an electrical spark, direct it towards a revolving mirror; after having divided it, and caused one part to travel through air, and the other through a tube filled with water, then to receive and study the reflected images. such was the experiment to be tried. Whether the water accelerated or retarded the motion, it must, at all events, prevent the two rays arriving simultaneously at the revolving mirror. That which should arrive first was to fall upon the mirror in a certain position, and the ray subsequently arriving would meet the mirror in a more advanced part of its revolution. The principle was obvious, and all the difficulty of the experiment lay in seizing the reflected image which would render sensible the motion of deviation, if it really took place.

Obstacles of various kinds stood in the way of the accomplishment of the experiment. An apparatus was at length invented by M. Foucault, at great expense and much mental labour, which may be described in outline as follows:—A beam of light, to which a horizontal direction was given by means of the heliostat through a narrow aperture in a dark chamber. was made to fall upon a revolving mirror. The rapid rotation of the mirror threw upon the sides of the chamber a slight luminous track, in which another mirror was so set that it reflected the rays thrown off by the revolving mirror. The rotatory motion of the latter being very rapid (600 to 800 revolutions per second), the duration of the journey taken by the ray in passing from the revolving to the fixed mirror, and back again, was sufficiently long to allow of the first mirror changing its position, so that the ray on its return would take the new direction given it by the altered angle of that mirror. To ascertain and measure the deviation of the new from the old direction was the problem, and M. Foucault, by means of his ingenious apparatus, has succeeded in solving it. The deviation is found to be proportional to the velocity of rotation, as well as to the length of the space travelled over by the ray. Again, the deviation is evidently greater after the ray has passed through water than through air, and we may, therefore, conclude that water is an obstacle to, instead of favouring the transmission of light, and thus the notion of the advocates of emission is proved to be erroneous.

In considering experiments such as these, every one must be struck with the wonderful nicety and ingenuity of the processes adopted for working them out. Is it not marvellous that man has the power, within the narrow bounds of a room, and by means of an apparatus of little more than sixteen feet in length, to measure with precision the prodigious velocity of a fluid as subtle as light, and to appreciate a portion of time so small as the thousand-millionth part of a second?

M. Foucault has founded on these experiments a general method for measuring not only the relative velocities of light in various media, but also the velocity with which caloric radiates. With these interesting questions he is still engaged.

STIRLING'S PATENT WROUGHT-IRON AND ALLOYS.

In the August number of the *Practical Mechanic's Journal*, we drew attention to the very valuable results obtained from Mr. Morries Stirling's process for toughening and strengthening cast-iron, as a branch of practical improvement in which that gentleman has been eminently successful. As a sequel to our former notice, we have now to introduce to the practical mechanic the several other equally valuable compounds of wrought-iron, and alloys of the more costly metals, which have been elucidated in the course of Mr. Stirling's elaborate researches.

For the strengthening of malleable iron, an alloy is made with block or grain tin, the mixture being accomplished in the puddling-furnace. The addition of so small a quantity as a two-hundredth part of tin, produces a marked change in the appearance and quality of the iron; and a proportion of one-hundredth produces a metal which breaks with a crystalline fracture, but works well under the hammer whilst hot, as well as in the squeezer, the rolls, and the smithy, and has a fine smooth surface. This compound answers admirably for rolling, in combination with common iron, to form the upper surface of rails and for similar purposes, where an anti-laminating quality is essential. Bismuth, antimony, and arsenic, may in like manner be used, with a somewhat similar effect.

The addition of zinc, whether metallic, or as an oxide or carbonate, as calamine, has also a very powerful effect upon malleable-iron, which thus becomes brighter in colour, and of a clearer surface, whilst it retains its ductility and fibrousness. Copper added to the metal thus treated, hardens the malleable-iron. A very slight proportion only is used—not more than from a two-hundredth to a one-hundredth of the mixed iron.

Manganese, mixed with cast-iron, gives the resulting malleable-iron made according to any of these processes a more steely character; the black oxide of commerce, in the proportion of one per cent., renders the puddling process more rapid, and gives increased hardness.

The process adopted in the improved manufacture of wrought-iron is this,—Common-iron being brought to a thoroughly liquid state in the puddling-furnace, a proportion of from 3 to 4 lbs. of calamine, to every puddling charge of 4¼ cwt., is thrown amongst it, and well incorporated with it. When forged, or squeezed, and drawn through the rolls, it becomes No. 1, or puddle-bar, but it is in reality nearly equal in quality to No. 2 of the ordinary iron; and a second rolling brings it up to an equality with No. 3, or best bar, thus effecting an economy in the manufacture to the extent of one entire process. Instead of common iron, No. 3, or No. 3 extra, toughened pig, may be used. Wrought-iron made from this is of a remarkably fibrous nature, the fibres being also much finer than when common iron is employed.

By another process, a proportion of from 2 to 4 lbs. of tin, or from 1½ to 3 lbs. of metallic antimony, is added in the puddling-furnace to each charge of 4¼ cwt. When boiled or puddled, squeezed, and rolled into No. 1, or puddle-bar, the product is a very hard, crystalline, or anti-laminating iron. This is admirably adapted for the manufacture of rails and wheel-tires. When adopted for this purpose, a pile is made up of from three-fourths to five-sixths of No. 1 calamine-iron, and from one-fourth to one-sixth No. 1 anti-laminating iron, the mass being rolled to the requisite section, having the anti-laminating metal on the upper surface of the rail, or on the outside of the tire. The junction of the two kinds of metal is quite perfect, as evidenced in several specimens now before us. The increase in cost, for securing this vital advantage of an anti-laminating quality, is only 7s. 6d. per ton.

The excellent report of the commissioners appointed to inquire into the application of iron to railway structures, furnishes some useful data as to the ascertained strength of the iron, under various tests. The accompanying tabulated statement refers to tensile strength:—

Experiments, where made.	Description of Iron used.	Average Breaking Strain, in Tons per square Inch.	Average Stretch in a length of 2 feet.			Remarks.
			10 Tons	15 Tons	Final	
			In.	In.	In.	
Liverpool, by Mr. Jessie Hartley,.....	Experiments made at Liverpool, by Mr. Jessie Hartley,.....	23.23	...	...	...	
Average of numerous trials at Woolwich Dockyard,...	S. C. Crown Iron,.....	21·47	...	...	...	
Ditto, ...	Dundyvan, best Bar,.....	24·33	...	½	3½	
Woolwich Dockyard, ...	1. Dundyvan No. 4 Pig Iron, ...46 lbs. Wrought Scrap, 10 lbs.	27·81	...	⅛	5	Very stiff strong iron, breaking with a long fibre, and working well under the hammer at welding and red heat, neither hot nor cold short.
	Cwt.qrs.lbs. 2. Dundyvan Iron, common, ...4 1 0 Calamine,.....0 0 4	25·86	...	⅜	3⅝	Similar in its qualities to the above.
	3. Nearly the same as No. 1, ...	27·7	...	1/12	5 3/16	Ditto.
	4.* No. 2 Pig Iron, 40 lbs. Wrought Scrap, 16 lbs.	24·33	...	9/16	5½	This iron is intended for wire-drawing, and for other uses, when a ductile soft metal is required.
	Cwt.qrs.lbs. Dundyvan Iron, 4 1 0 Tin,..... 0 0 1	23·39	...	1/16	¾	For the wearing surfaces of rails for tires of wheels, and all purposes where a hard close-grained metal is required.
	Dundyvan Iron, 4 1 0 Tin,..... 0 0 3	22·92	...	1/16	¼	

This detail presents the means of comparing the alloyed metal with the iron from which such alloy is made. The following table exhibits the deflections and permanent set of several qualities, the first line referring to common Dundyvan iron:—

* Melted in the cupola and then puddled.

Description of Iron used.	1 Cwt.	2 Cwt.	3 Cwt.	4 Cwt.	5 Cwt.	6 Cwt.	7 Cwt.	8 Cwt.	8½ Cwt.	9 Cwt.	9½ Cwt.	Permanent Set.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
Dundyvan,	·04	·08	·12	·18	·22	·28	·5	1·4	1·9	2·2	2·6	2·12
No. 4 Pig Iron, 46 lbs., ... Wrought Scrap, 10 " ..... Cwt. qrs lbs.	·08	·12	·17	·21	·25	·3	·39	·96	1·38	1·81	2·16	1·78
Dundyvan Iron, 4 1 0 Calamine, ... 0 0 4	·08	·14	·18	·22	26	·31	·38	·59	1·06	1·14	1·66	1·08
No. 2 Pig Iron, 40 lbs., ... Wrought Scrap, 16 " ... Cwt. qrs. lbs.	·03	·12	·17	·2	·4	·7	1·8	2·6	2·72	2·94	3·5	3·1
Dundyvan Iron, 4 1 0 Tin, ... 0 0 1	·08	·11	·18	·22	·24	·32	·4	·56	·78	1·04	1·42	1·02
Dundyvan Iron, 4 1 0 Tin, ... 0 0 1 Calamine, ... 0 0 4	·08	·11	·18	·22	·26	·32	·42	·8	1·12	1·5	1·98	1·52
Dundyvan Iron, 4 1 0 Tin, ... 0 0 3	·06	·1	·16	·2	·26	·3	·4	·82	1.16	1·6	2·02	1·6

In alloying zinc and iron, Mr. Stirling's plan is to place in a cupola-furnace, which has been used for melting either cast or wrought-iron, and from which the charge has been run off, a quantity of zinc, which, melting easily, passes through the fuel, and, coming in contact with the sides of the furnace, mixes with portions of the adhering iron. In this way an alloy of zinc, with from four to seven per cent. of iron, is produced; and this alloy is adopted instead of zinc alone, in the production of such alloys as are applicable for purposes for which brass and gun metal are now used.

A very beautiful alloy, closely resembling gold, and named, from this reason, "British Gold," is made by mixing this alloy of zinc and iron, with from one-sixth to one-fourth of an alloy of copper and manganese. The latter composition is produced by adding to melted copper a proportion varying from a two-hundredth to a fiftieth part of black oxide of manganese, covering the surface of the metal with a reducing flux, in order to reduce the oxide to the metallic state, and to prevent the access of air to the metal. When these two compounds are amalgamated, in the proportion of four parts manganese and copper to one of zinc and iron, a metal closely resembling standard gold is produced. A variation in the proportions of the two alloys correspondingly affects the colour, hardness, and tenacity of the compound. As both the manganese and zinc have a hardening effect, a smaller quantity of one or both is to be used when a rolling metal is required, but the proportions we have stated give an easily workable and finely coloured metal, possessing great malleability and ductility, and capable of a fine polish. A metal of good colour may be obtained by using zinc alone, instead of the alloy with iron, or by substituting copper alone, instead of its alloy with manganese.

In all these alloys a small quantity of tin gives increased hardness. For some purposes, more particularly bearings, and portions of machinery exposed to frictional wear, the presence of from one to three per cent. of lead has a tendency to prevent heating.

To produce an alloy possessing the colour and many of the properties of silver, but superior to other imitations of that metal in colour, brilliancy, and susceptibility of polish, the alloy of zinc and iron is mixed, in various proportions, with copper and nickel, and with copper and manganese and nickel. Ten parts of copper, two of nickel, six of zinc and iron; or eight parts of copper, two of nickel, and four of the zinc and iron, are good proportions for this purpose.

The behaviour of the metal intended for sheathing, bolts, and other similar purposes, when under test by Mr. Owen, of H.M. Dockyard, Woolwich, is shown by the following—

Abstract of a Statement made to the Lords of the Admiralty, June 4th, 1848.

"The first series of experiments was made at Chatham on the patent alloys, for the purpose of ascertaining how the metal could be rolled and worked.

"It was reported—That the metal could be rolled as easily as copper into bolt-staves, or sheathing, and at a heat not essentially different. Bolt-staves, then rolled, were tried at Woolwich in the chain-testing machine, and broke with a strain of *twenty-seven* tons per square inch, being higher than any other metal used for such purposes. Iron breaks with a strain of 23 tons, and copper with 21·15 tons.

"The next experiments were tried at Woolwich, for ascertaining the strength of the metal as compared with the best sorts of gun-metal. Its object was to determine how far it might be a substitute for gun-metal in general castings, such as screw-propellers, frame-work, bolt and deck nails, &c.

"It was reported—That gun-metal broke at 11 tons, whilst, under precisely similar circumstances, the patent metal broke at 16 tons.

"An experiment was then made on the stiffness of the two metals, as follows:—Bars of equal diameter (¾ square inch) were placed on supports at equal distances (2 feet 3 inches), and were then loaded with the same weight (6½ cwt.) in the centre.

"It was reported—That the gun-metal bent in the centre $5\frac{7}{16}$ inches, whilst the patent metal bent $1\frac{3}{16}$ inch; or, as 18 is to 87.

"Another series of experiments on the manufacture and driving of bolt nails, was made at Portsmouth, with satisfactory results to all parties. A further series of experiments on their manufacture and comparative strength was again made both at Portsmouth and Chatham, and reported satisfactory. All these experiments proved that the saving would be as great, at the average price of copper, as was at first stated. That is, that when copper is £100 per ton, the alloy would be £80 per ton. In addition to this, a saving is made of £4 per ton, owing to its lesser specific gravity.

"I would recommend its application to the following general castings: screw-propellers, frame-work, air-pumps, cylinders, &c., bolt-nails, deck-nails, sheathing-nails, (as recommended by Mr. Owen, the late supervisor of metals in the dockyard at Woolwich, who has tested the galvanic properties of the metal, and who has found it electro-positive to all copper, a quality which other sheathing nails do not possess); also for bolt staves, piston rods, and other uses where a metal that can be rolled like copper is required; also for sheathing, as it is much less acted upon by salt water, and other corrosive substances, than copper or gun-metal, and on account of its closeness of texture, enabling the workmen to gain a greater smoothness of surface. A corresponding increase of galvanic action is acquired, thereby decreasing fouling."

Most satisfactory evidence of the durability of the new alloy when applied for axle bearings, is afforded by Mr. Wright, of the carriage department of the *London and North Western Railway*, who, up to the end of 1848, had used no fewer than 3,000 of them for carriage axles; and by a report from the *South Western Railway*, dated April, 1849, we find that two bearings, in van No. 25, put to work in June, 1848, and taken out in March, 1849, ran close upon 60,000 miles, and were not worn out when removed.

Messrs. Mears of Whitechapel, the eminent bell-founders, have used these alloys for nearly every possible purpose with great success, and the practical experiments in rolling, tried at the Cwm Avon copper works, show the remarkable facility with which they are worked. The great improvement in machinery bearings, which the introduction of the new metal has everywhere brought about, satisfies us that we render good service to the practical mechanic by bringing it under his notice.

ON A METHOD OF COOLING THE AIR OF ROOMS IN TROPICAL CLIMATES.

By Professor Piazzi Smyth, Astronomer Royal for Scotland.

Before an inventor can expect to enlist any interest in his labours, he must fully state the case to which they refer, must show that sufficient importance attaches to it, and should give an account of what others have done in the same direction before him; so that it may be generally understood at what point of the question he has taken it up, and whether he has really and essentially advanced it. The limits of this article will not allow of these desiderata being so fully treated of as they deserve, but very few persons in this country having had the opportunity of becoming practically acquainted with the case, of experiencing the intense necessity of some alleviation of the evils which it brings, and of witnessing the imperfect action or the mistaken principles on which the various remedies act which have been attempted up to the present time, —some small portion of the space which ought, perhaps, more strictly to be devoted to *new* matter, may be profitably employed for this purpose.

The heat which is occasionally felt in temperate climates, cannot call for any serious means of alleviation, as it never rises to a degree dangerous to health, or obstructive to business: it never lasts long, and there are always means of tempering it, in the coolness of the nights and of the winters, as stored up for our use in the earth, cellars, wells, springs, and mountains. Nor is the heat of the countries between the temperate and the torrid zones such as to call for much attention: its general characteristic is dryness, constant blue sky and sunshine; the heat is felt there as *radiation* rather than *temperature;* the rays of the sun are scorching; but, in the shade and at night, coolness is to be obtained. Such a climate is very healthy, as is shown by the instances of the Cape of Good Hope and Australia. Working in the open air may perhaps be too severe for some European constitutions, but those whose employment is in-doors, may get through with their business, nearly as well as in this country.

But it is in tropical countries, especially along the sea-coasts of continents and on islands, where heat exists in its most baneful form, as high temperature through day and night, and summer and winter; the sky may be constantly cloudy, or clear by day and rainy at night, the rain descending in a temperature of 80° Fahr. and upwards. In such a climate the shade of trees or of a roof brings no alleviation of the heat; it is felt almost equally all through the night, and throughout the winter as well as the summer. A person employed in-doors, is working in the same high temperature as one out of doors; there is no escape from the heat either by building houses high up into the air, or sinking them low down into the ground. Rivers, springs, rain, the ground, everything will be of the same temperature as the atmosphere, and that temperature is far too high for European constitutions.

Against a moderate continuance of even such an untoward climate as this, a strong constitution might bear up; but when this state of things goes on month after month, and year after year, the human frame becomes completely relaxed; all energy of mind and body is destroyed, and disease finds easy victims. We have but to turn to any statistical account of life, or rather death, in India, to see the immense sacrifice that is yearly being made there to the climate. Doubtless many of the deaths may have arisen from indirect effects of heat, such as miasma, which it is not within the province of this paper to touch on; but still, multitudes will be left amongst both soldiers and officers, and civilians of every degree, due merely to the living in too high a temperature; which prevents the skin, the lungs, and the liver, from performing their duties, and utterly relaxes the whole component tissue of the body, producing such diseases as *prolapsus ani*.

This now is the case to be met, and for proofs of its sufficiency of claim to earnest attention, let any one look merely to their own friends or relations who have gone out to India, and let them also consider those who have been so fortunate as to return, with—more or less grievously shattered constitutions.

It may be objected, that no plan of cooling rooms, though ever so effective in itself, can be of avail to by far the greater number of cases, where the persons are employed chiefly in the open air. It is true that it will be of no use to them while they are there, but if they can be insured, when the day's work is over, a *cold* house to retire to, and a sound sleep in a cool atmosphere; that may completely reinvigorate their bodies, and make up for all that has been undone by the heat outside; in the same manner, as in cold countries, men are enabled to withstand excessive severities of cold in open air employment in the daytime, if they can recruit their stock of heat at night in a warm lodging.

In cold countries, when the air is lower in temperature than is agreeable, nothing is easier than, by lighting a fire in a room, to raise the heat to anything that may be desired. But when the air is too high in temperature naturally, and in one of those tropical countries where day and night, and summer and winter, the heat is never under 80°, and where the air being saturated by moisture, there is no coolness from evaporation; then the converse of lighting a fire, that is to say, a method of actually lowering the temperature of the air, without producing any other change in it, has never yet been brought about. Some method of this sort, however, seems indispensable to give European life a fair chance in the tropics; and the method which I am about to detail, is my contribution to a subject, which I trust will receive continued attention until the problem is completely and satisfactorily solved.

On the methods hitherto adopted, much time need not be spent; for, 1st, The *fan-mat*, or "*punkah*," is merely a fan which agitates the air in a room already hot, but does not actually cool it, or produce any regular and salutary ventilation. 2d, The *wet mats* in the windows for the wind to blow through, cannot be employed but when the air is dry as well as hot; and even then are most unhealthy, for although the air may feel dry to the skin, there generally is far more moisture in it than in our own climate; but the height of the temperature increasing the capacity of the air for moisture, makes that air at 80° feel very dry, which at 40° would be very damp. Now, one of the reasons of the lassitude felt in warm climates is, that the air expanding with the heat, while the lungs remain of the same capacity, they must take in a smaller quantity by *weight*, though the same by *measure*, of oxygen, the supporter of life; but if, in addition to the air being rarified, it be also still further distended by the vapour of water being mixed with it, it is evident that a certain number of cubic inches by measure, or the lungs full, will contain a less weight of oxygen than ever; so little, indeed, that life can barely be supported,—and we need not wonder at persons lying down almost powerless in the hot and damp atmosphere, and gasping for breath. Hence we see that any method of cooling the air for Indians, instead of adding, should rather take, moisture, out of the air, so as to make oxygen predominate as much as possible in the combined draught of oxygen, azote, and a certain quantity of the vapour of water, which will always be present; and hardly any plan could be more pernicious than the favourite, though dreaded one by those who have watched its results,—of the wet mats. Cold air, *i. e.* air in which the thermometer actually stands at a low reading, by reason of its density, gives us oxygen, the food of the lungs, in a compressed and concentrated form, and men can accordingly do much work upon it. But air which is merely cold to the feelings, air in which the thermometer stands high, but merely gives us one of the external sensations of coolness,—on being made by a punkah or any other mere blowing machine, to move rapidly over our skin; or on being charged with watery vapour, or on being contrasted with previous excessive heat; such air must nevertheless be rarified to the full extent indicated by the mercurial thermometer, and gives us therefore our supply of vital oxygen in a very diluted form, and of a meagre, unsupporting, and unsatisfying consistence. The only other Indian plan to be mentioned, is shutting up the house in the middle of the day, and opening it only at night, or towards morning; but this evidently will not suit the strictly tropical heat, and can only be employed in the northern and inland portions of India, where the climate is more nearly like that of the "radiation" countries, where the nights are cool; for, otherwise, the closing of a room will evidently be no safeguard against the heat which has already saturated the walls, the roof, and the floor; and if a human being be enclosed in that space, he will evidently warm up the confined air, in addition to contaminating it by his respiration. The *sine quâ non*, therefore, for healthy and robust life in tropical countries, is air cold and dry, cold to the thermometer, and dry to the hygrometer, or in other words, dense, and containing little else than the necessary oxygen and azote, and this supplied to a room, fresh and fresh, in a continual current.

The method by which I propose to accomplish this consummation, so devoutly to be desired, is chiefly by taking advantage of the well-known property of air to rise in temperature on compression, and to fall on expansion. If air of any temperature, high or low, be compressed with a certain force, the temperature will rise above what it was before, in a degree proportioned to the compression. If the air be allowed immediately to escape from under the pressure, it will recover its original temperature, because the fall in heat, on air expanding from a certain pressure, is equal to the rise on its being compressed to the same; but if, *while the air is in its compressed state, it be robbed of its acquired heat of compression*, and then be allowed to escape,—it will issue at a temperature as much below the original one, as it rose above it on compression. Thus the air, being at 90°, will rise, if compressed to a certain quantity to 120°; if it be kept in this compressed and confined state until all the extra 30° of heat have been conveyed away by radiation and conduction, and the air be then allowed to escape, it will be found, on issuing, to be of 60° of temperature. If a cooler be formed by a pipe under water, and air be forced in under a given compression at one end, and be made to pass along to the other, it may thereby, if the cooler is sufficiently extensive, be robbed of all its heat of compression; and if the apparatus is so arranged, as it easily may be, that at every stroke of the pump forcing in air at one end of the pipe, an equivalent quantity of the cooled compressed air escape from under a loaded valve at the other, there will be an intermittent stream of cooled air produced thereby of 60° Fahr., in an atmosphere of 90° in the numerical case just given, which may be led away in a pipe to the room desired to be cooled.

So much for the theoretical principle of this operation of, as it were, squeezing the heat out of the air; but before thinking of it for practical purposes, it is necessary to ascertain what is the thermotic effect of compression, *i. e.* how many degrees in temperature a certain quantity of air will rise, on experiencing a given compression. On this, combined with the cost of mechanical power at the place, will depend the expense and the consequent feasibility of the method. Seeing that that can be accomplished by this method, which has not yet been brought about by any other, it is probable that it might be adopted by the wealthy who are dying from heat, although it might be very expensive; and in hospitals, also, where many subjects are concentrated together, and are more immediately in want of the benefits of cool air—the plan might be adopted, although very troublesome; but it fortunately turns out that the thermotic effect of expansion is so very great, that the machinery can therefore be made very simple, and can be worked so cheaply, that private persons of ordinary means may indulge in the luxury; and a house may be cooled in India for probably about the same that one can be warmed in England.

The mere fact of compression and expansion having a thermotic effect on air had long been known, but no one seems ever to have thought of applying it to any decidedly useful purpose, certainly not this one; and for that reason, perhaps, the exact quantity of thermotic effect had never been investigated with precision; and when this idea first occurred to me in 1843, I could procure no data which would enable me to calculate

its practicability within any moderate limits. The next year, however, I had a small apparatus constructed for testing the matter experimentally; and though no great exactness was arrived at, still it appeared that sufficient grounds were obtained to warrant the communication of the idea to several friends in 1845, as a possible mode of accomplishing the end in view. In 1847, I had a larger apparatus made; and, in the beginning of 1849, communicated an account to the Royal Society of Edinburgh.

Experiments, however, with small apparatus, are very uncertain, where heat is concerned; and in this case the results were not by any means so favourable as they might have been, on account of the great radiation and conduction of heat, due to the diminished size of the metallic vessels, and the consequent preponderance of surface to cubical contents. But in the latter end of 1839, I was enabled, through the kind intervention of Mr. Stirling, C.E., to try the experiment on as large a scale as could possibly be desired.

At the Kinniel Iron Works (the nearest works of that description to Edinburgh), air is pumped into a series of blast furnaces by a powerful steam-engine, under a pressure of 3·5 lbs. on the square inch. The air-pumps are two in number, double acting, with cylinders about 5 feet in diameter, and 10 feet stroke; so that, in so far as a compression of 3·5 lbs. could serve, the volume of air was prodigious, and completely removed all fear of sensible error arising from the frictional heat of the piston, or from radiation at the surface. Mr. Wilson, the owner of the works, very kindly, on the application of Mr. Stirling, gave every facility for trying the experiments, and I had a new thermometrical and mercurial guage apparatus constructed for the purpose.

The observations, which it is needless here to detail in full, as they will appear elsewhere, were made in the presence, and with the assistance, of Mr. Stirling, C.E., and Lieutenant Driscoll Gosset, R.E.; and consisted in determining, by a considerable number of trials,—1st, The temperature of the air entering the valves of the air-pump. 2d, The temperature of the air in the large air-vessel, into which it had been forced by the pumps under a certain pressure. 3d, The degree of that pressure; and, 4th, The temperature of the air on issuing out into the atmosphere from under that pressure. For these last it was necessary to bore a hole into the air-chest—and this Mr. Wilson most freely allowed us to do—and the hole being above one inch in diameter, the rush of air out of it was more than sufficient to completely enclose and fully impress its temperature on the bulb of the thermometer.

The results were—

1st, Temperature of entering air,... 63° Fahr.
2d, Temperature of compressed air, 92°.
3d, Compression, ... 7·2 inches mercury.
4th, Temperature of escaping air,... 63°.

The barometer was about 30 inches at the time. The temperatures may be considered to be determined certainly within a degree less or more, and the pressure within one-tenth of an inch. Hence we have, with a very small probable error, a compression of 7·2 inches of mercury—less than $\frac{1}{4}$ of an atmosphere—raising the temperature of air 29° Fahr., or from 63° to 92°; and on being allowed to escape and expand from that pressure freely into the atmosphere, the fall of temperature is also 29°.

This result was immensely above what any friends to whom I had mentioned the matter had anticipated, and they would have been inclined to doubt, had not these experiments been so unexceptionable in the huge scale of the pumps employed. The workmen at the place were well aware of the heat of the air in the compressed vessel and pipes, and the instant that the hand was laid on the large reservoir into which we bored the hole, the great increase of heat was perceived. The men had very absurdly, but very confidently, been in the habit of attributing the heat to the *friction* of the air in the pipe; but, in the first place, the air was almost stationary in that pipe, which was some five feet in diameter; and, in the next place, when the air was allowed to escape through a 1 inch pipe, and so produce incomparably more friction, the *fall* of 29° was obtained, instead of any further increase.

Professor W. Thomson being employed on the theory of heat about this time, and being engaged in preparing an account of Carnot's theory, I applied to him to know what the increase of heat would be, if air at 70° Fahr. was to be compressed $\frac{1}{4}$ of an atmosphere, the barometer being 30 inches. He replied, that some of the elements required for the calculation were not exactly known, but that, as near as he could compute it then, it would be 30° Fahr., which is a remarkable confirmation of the 29° for 7·2 inches derived from experiment.

Mr. W. Macquourn Rankine, C.E., who last winter produced his mathematico-mechanical theory of heat, states, that it gives the same result as the above; so that, for practical purposes and small pressures, we may take very safely 4° Fahr. as being the rise in the temperature of air for 1 inch pressure of mercury, and 30° Fahr. for 7·5 inches, or $\frac{1}{4}$ of an atmosphere; and Mr. M. Rankine further computes that a theoretical horse-power working one hour, will be sufficient to lower 9000 cubic feet of air 20° Fahr., without any deduction for friction.

Making a very liberal allowance for friction, for loss of effect by radiation of heat, and for imperfect cooling of the compressed air, and calculating from the Kinniel experiment, a one-horse power (which in India would generally be represented by a pair of bullocks, and might cost, with their driver, two shillings per diem) would be enabled to furnish a room with from 50 to 70 cubic feet of air per minute, cooled 20° Fahr. below the surrounding atmosphere. This being a quantity of air abundantly sufficient for the breathing of one or two persons at least, and 20° being quite sufficient depression of temperature for the inside of the room below the atmosphere outside, we see that, in so far as the element of mechanical force is concerned, the expense is nothing extraordinary; certainly trifling to an Indian purse. In some places, the regular blowing trade-winds, and, in others, water power, may give the means of producing mechanical force still cheaper. Sometimes the abundance of fuel may render a steam-engine convenient, but seldom need the necessary power cost more than the bullock hire; and this element of expense, which is to be compared, in the warming economy of colder countries, with the price of coal, is reduced within very possible limits indeed.

But we have next to consider the form and size of the apparatus to which the mechanical power shall be applied, not only in order that this may be used to the best effect, but to contract as much as possible the first cost of the whole; a capital to be compared to that sunk in cold countries, in furnishing a house with grates and chimneys. Then a method has to be devised of supplying the air, thus produced, to a room, in such a manner as to produce perfect ventilation; and, lastly, a plan of *drying* the cooled air, should that be found necessary, as is not at all improbable.*

THE EXHIBITION OF 1851.

The actual execution of Mr. Paxton's elegant design for the Exhibition Building, and the energetic manner in which the detailed preparations are now being made by the Royal Commissioners, are unmistakeable hints to producers of every grade, to make the most of the now short extent of time assigned for the reception of claims for exhibition space. We have again and again urged the pressing necessity for an active movement on the part of all who identify themselves with the industrial interests of the British nation, and consequently have at heart the due representation of their country in that congress of nations, which we ourselves have convened. Our challenge has been echoed from every corner of the globe, in a spirit breathing the fullest expressions of an intention of meeting on our shores, backed by every appliance which the combined efforts of the competing industrialists can produce, to secure a fair exposition of their wares. Let us then not forget, that whilst to us belongs the merit of being the originators of the undertaking, on us also rests the responsibility of proving that we do not unworthily fill the proud station which we have chosen.

The approaching time of summing up the varied lists of contributions will inform us as to the part which each district means to play—it is then to be hoped, for the honour of industrial Glasgow, that she will make a fair appearance in the catalogue. As a spur for the exertions of her representative labourers, we constantly read of the spirit with which competing producers have entered the lists, and the large extent of space for which they boldly ask.

If any other inducement for exertion were required, we might look at what is doing abroad. Nearly every foreign nation has at once accepted its allotted space, and many, amongst which are Switzerland, Russia, and Austria, have actually demanded additional room. To the United States, 80,000 square feet has been assigned, and this vast area has just been judiciously subdivided to suit the capabilities of each State; and whilst we write, an industrial fair is being held in Montreal, for the careful selection of such articles as may be deemed worthy of entering for competition here. The King of Sweden has set aside a fund for the collection and purchase of specimens of the valuable iron of the country, and the chief of the Persian merchants has received orders to prepare and transmit the choicest productions of the East. The countries with which negociations have been opened, are France, Belgium, Bavaria, Netherlands, Saxony, Hanover, Sweden, Norway, Russia, United States, Chile, Wurtemberg, Nassau, Venezuela, Prussia, Austria, Hesse Darmstadt, Bremen, Turkey, Spain, Hamburgh, Switzerland, Peru, and Persia; and from each, the commissioners have received the liveliest demonstrations of interest in the contest. The following address from the pen of M.

* We shall conclude this article next month, with illustrative details of the air-cooling mechanism.—Ed. P. M. Journal.

Dupin, forms in itself an exposition of the intended bearing of France in the matter:—

"No living being," says the author of this excellent statement, "is entitled to claim perfection for the arts useful to man. They are progressive in their very nature, and often when they are thought to be carried to the very highest point of excellence, an unexpected discovery opens to them a new career. There are no longer mysteries in works enlightened by science; everywhere theory is sufficiently advanced to produce anew the discoveries of processes of which the simple result is made known. Such are the motives which should encourage us to exhibit to the world even our means of production. We ought more especially to do this in a competition where our rivals will also show us theirs."

Artificial Porphyry.—At Sarreguemines arose our manufactures of artificial porphyry, appropriate only to the splendour of temples and palaces.

Porcelain.—The manufacture of porcelain is an art where French genius finds a field for its combined excellences—economy in fuel, simplicity in mechanical contrivance, taste, and elegance of form, colour, and design; these are what foreigners appreciate in our cheap, elegant, and beautiful porcelain. Limoges and Paris will prove at the Exhibition of London the respective merits of their manufactures.

Glass.—In the common kinds of glass, as in pottery and wrought-iron, the price of fuel is our adversary.

We enter the lists with advantage in the superior manufactures of glass; we must exhibit our mirrors, polished by an improved process—our glass, coloured by an ingenious chemical application—and the glass manufactured with zinc instead of lead, which gives promise of increased refractive power to our lenses for optical and astronomical instruments.

Woven Goods.—The manufacture of thread and woven goods presents so many branches where we hold the highest rank, that we may, without hesitation, acknowledge there are some in which we cannot maintain a competition with England; such as the spinning of cotton by machinery, which originated in England twenty-five years earlier than in France. At the present day we can spin it equally well, but not at so low a price.

Printed Cottons.—By unceasing efforts we are able, nevertheless, by means of system and economy, to introduce some of our printed and dyed fabrics even into the markets of Britain; this honour is shared by the unpretending fabrics of Rouen, as well as the richer productions of Alsace. Generally, our wool is dearer than that of England, so also, for the same reason, is our worsted yarn and common cloth; there are, nevertheless, certain kinds of spun wool supplied by us to England.

Fine Cloths.—Notwithstanding the disadvantage of price in the raw material, our fine cloths, kerseymeres, our mixed stuffs, and our so-called Ternaux shawls, find enlightened purchasers in the British markets. The article merinos alone, figures in our exports at the sum of five millions of francs (£200,000); a careful selection must be made of these various products, to be sent to the Exhibition.

Carpets.—Generally, our common carpets have not the advantage of cheapness, but our richer carpets and hangings are unrivalled. Fine art, allied to mechanical skill, augments still further the merit of this manufacture.

Silk Goods.—I now come to the most brilliant of our textile products, to the manufacture of silks. Notwithstanding the high duty which England continues to levy on French silk goods, which is a flattering admission, we have here the proportion which England buys from us in comparison to the rest of the world:

WOVEN SILKS SOLD BY FRANCE.

	To England.	To all other countries.
Figured silks,	20	100
Plain silks,	47	100
Silk ribands,	57	100
Silks mixed with other material,	50	100
Silk lace,	51	100
Fancy goods,	56	100

We hope that Lyons, St. Etienne, Avignon, and Nismes, will show the productions of their ingenuity, from the goods remarkable for their lowness of price, up to the *chefs d'œuvre* of elegance and richness. We ought also to be able to exhibit our superiority in another kind of fabric, that of hemp and flax, if we had availed ourselves at first of a French discovery of the means of spinning flax by machinery; the Scotch and English have borrowed our invention, to forestall us: they have got a-head of our sluggards, and it is just.

Parisian Stuffs.—The tasteful hand-work of Parisian industry has given to all our textures a superior elegance which heightens the merit of the stuffs in general use, prepared in our workshops of Paris; a considerable part of these stuffs is sold to England—scarcely necessary, I think, to offer this weapon against us at the English customhouse.*

Fibres of Bark.—We have already spoken of cotton-wove goods; let us now point out a humble kind of material, which may prove of importance in Algeria; it is that obtained from the fibres of bark or of reeds. The simplicity, the cheapness, the elegance even, of these productions, recommend them for summer apartments.

Paper.—The foreigner appreciates our card-work in its varied forms, and our finer papers are worthy of figuring beside the best English papers.

Printed Paper Hangings.—We have brought to a high state of perfection our printed paper-hangings, both for beauty of colouring, for their adjustment, and for elegance of design. It is important that our most beautiful specimens should be exhibited, as well as those of the cheapest kinds.

Printing.—Printing, considered simply as a mechanical art, allows no longer of superiority among nations where the arts are already advanced.*

Printing Scientific Works.—But the printing of works requiring both science and erudition, marks always the intellectual advancement of nations by the perfection of its greatest enterprises. It is honourable for France to offer works of this description, either very lately completed or in the course of execution. France possesses at least one family of printers who revive again the Estiennes, the Aldi, and the Elzevirs, in combining the technical skill of their profession with the learning, the taste, and the genius of those fathers of literary and scientific typography. Among the monuments of French typography must be reckoned the matchless collection of types of the Imprimerie Nationale. I should instance more particularly the separation into parts of the Chinese characters, invented and carried out by a Frenchman, in order to obtain results of which the Chinese themselves are not aware.

Printing Music.—The printing and engraving of music have made most remarkable progress, through the ingenious combination which our typographers have invented.

Expeditious Printing.—The English have originated the continuous impression employed by the newspapers. An invention, which is now being perfected, will enable us to offer to London the means of obtaining, in the shortest space of time, the multiplication to an almost unlimited extent of the copies of a newspaper.†

French taste has carried to a great extent the branch of fancy printing for visiting cards and circulars of all kinds with the most diversified ornaments.

Lithographic Printing.—Lithography, both plain and coloured, has made unceasing progress. We are enabled to show works of the most varied kinds, which satisfy most thoroughly on the one side the cheapness demanded by ordinary trade, and, on the other, all that can be required by fine art in taste, elegance, grace, or power.‡

England purchases from us yearly, lithographs to the amount of nearly £40,000, that is to say, a larger value than all the books, foreign or English, that she borrows from our press.

Leather.—After having seen what may be required, both as to paper and in those works of which paper is the principal material, let us now direct our attention to skins or hides, and what they can be applied to.

Tanned Hides.—England purchases from France our tanned and dressed hides, which are used by its bootmakers; this article alone yields an annual business of three millions of francs (£120,000.)

Morocco Leather.—She appreciates equally our superior morocco leather. Even to this day, she finds it more advantageous to purchase our gloves than the lambskin of which they are made.

Gloves.—The art of cutting and sewing§ gloves, both for men and women, is one in which we excel.

Harness.—We possess, at present, the description of hides best adapted for the superior kinds of harness, and our first saddlers combine elegance of form with sound workmanship. We appeal to their spirit of enterprise to establish at the Exhibition at London a well-deserved renown for the harness of France, even at the side of that of England.

Carriages.—We call equally upon our most distinguished carriage-makers to send to London their town and travelling carriages, executed in the most finished style of comfort, elegance, and solidity. They possess materials of most perfect quality, wood, iron, brass, leather, colours, and varnish. Let them exercise their good taste and experience, and they will appear with honour.

Hats.—The hat manufacture of France is at present as varied in the materials it employs as in the ever-changing forms it applies them to; the hat manufacturer should, by strenuous efforts, attempt a competition, which it is in a condition to sustain with honour; to Paris and Lyons should be confided this task.

Straw Bonnets.—The elegant work of straw-bonnet making in French straw may equal the fabrics of Florence; it has already made progress in the English markets.

Sickles.—We ought to have been able to export to England our sickles and scythes, if we were better acquainted with the particular excellence of the raw material, which should ever be considered as the element of definite success.

Goldsmiths' Work and Jewellery.—Gold and silversmiths' work and jewellery are amongst the arts carried to the greatest perfection by the Paris workman. It is a glory to be sustained.

Strange! almost all our imports of goldsmiths' work into England are wrought in silver; while, on the contrary, our jewellery that she buys is almost all in gold.

Clocks and Watches.—The clockmakers of France sell annually to England clocks to the value of nearly £40,000, and of watches not one, either in or out of cases. The experiments in movements made by our manufacturers deserve a better fate; it is very desirable that they be exhibited.

Chronometers.—The construction of chronometers is carried on at Paris with a perfection that will stand the test of the most minute experiments of our astronomers, and the proofs at the Observatory. Our chronometers should be exhibited to show the state of precision to which France has brought this art.

Sic origine: "Une partie considérable de ces effets est vendue à l'Angleterre. Inutile, au moins je pense, de donner cette arme contre nous à la douane Anglaise."—Ed. P. M. Journal.

* Even "as a mechanical art" merely, we object to this assertion.—Ed. P. M. Journal.

† We presume this refers to the *Worms* machine. There is nothing in this invention which has not been long ago tried in this country, and found wanting.—Ed.

‡ The studies of *Jullien* alone, are examples of French superiority in chalk lithography; in line work we can show immeasurably better work.—Ed.

§ In leather making and cutting, no one disputes the superiority of the French, but their sewing is wretched.—Ed.

Machinery.—In the manufacture of machinery, it is not the genius of invention that is wanting in France: it is the low price of the metallic mineral of which they are more and more composed, and especially of iron and steel.

Notwithstanding this disadvantage, by economy of fuel and workmanship, and by means of certain kinds of machinery, we are enabled to export in this branch to the extent of half a million francs (£20,000) a year to England.

Locomotives.—Our manufacturers construct locomotives which, even in price, are on a level with those of Great Britain; equal also in workmanship. Let us compete in *locomotives!*

Fire-Arms, Swords.—We can exhibit also portable arms, guns, pistols, sabres, which combine every desirable quality—strength, precision, certainty in loading, elegance of form, goodness of temper, and taste in the ornaments. We have revived the manufacture of damasked arms; we equal in taste and richness the fine productions of Italy, Spain, and the East, even in the best eras of their works in this kind.

Surgical Instruments.—The foreigner seeks our surgical instruments for their ingenious form, their perfect temper, and their comparative cheapness; we fear not to state that no people have done more for humanity than our own, by contriving new or improved instruments for the most varied and important operations.

Parisian Art-Manufacture.—We will not enumerate the arts so various which constitute more particularly our Parisian trade. We know how the stamp of elegance, contrivance, or richness, characterises the works of the capital. We must make a selection of objects remarkable on the one hand for cheapness, on the other for richness, and always for taste.

Turned ware, fancy trimmings, and embroidery; fans, parasols, and umbrellas—all these objects, representing millions, taken collectively, acquire importance.

Artificial Flowers.—Let us not forget a branch of trade, which, assiduously studied, rivals nature itself; this is the production of artificial flowers in every possible variety. Of these, France sells to the extent of a million francs (£40,000) to the foreigner; and England, with the United States, purchases more than half this amount.

Cabinet Furniture.—In reviving the furniture of the Moyen-age, and of the Renaissance, as also that of the period of Louis XIV., the joiner and cabinet-maker have taken a remarkable position in our export trade. England is by far our largest consumer, and it is her approbation, therefore, we should the more endeavour to obtain.

Mathematical Instruments.—We are rivals with Britain in mathematical instruments, and in those of philosophy, optics, and astronomy.

Musical Instruments.—Our musical instruments are worthy also of comparison. We desire to see appear in this Exhibition of London, by the side of our harps and pianos with the latest improvements, our violins, tenors, and violoncellos; it is allowed that our best makers manufacture these stringed instruments equally as well as the most celebrated old Italian makers.

In wind instruments, we can exhibit to England every size of the organ, from the small instruments intended for an oratory up to the magnificent tones which are fitted for a cathedral.

Military Music.—It is especially in regard to military music that we can show that a complete change has been effected by the improvement of old instruments and the invention of new ones by France. The Horse Guards of England have borrowed from us these instruments for their band; it is a patent of excellence.

The softest and deepest of these new instruments enrich the orchestras of our concerts and our theatres. At present, brass no longer triumphs over the soft harmony of our expressive music, in blunting by dint of noise the delicacy of our auditory senses.

We have here a sketch, though certainly too incomplete, of the principal objects of our manufactures which appear worthy of exhibition to the assembly of all nations.

We are far from thinking that we have enumerated all the products, and all the means of production, which are worthy of competing at this Exhibition.

In such a wide field of industry as that of France, most of the arts are continually progressing; the greater number, it is true, by degrees insensible to the superficial observer—some of them are almost daily signalised by an unexpected improvement. Not a year has passed since the products exhibited last summer at Paris were completed: they represent no longer the state of perfection of our works; and next year, in the month of May, the difference will be greater still.

It will be for the exhibitors of France to carry out for 1851 *what they would do for our own Exposition of* 1854—*they must surprise us by bringing forward improvements and inventions of which we dare not yet claim the honour for our manufacturers.*

The space demanded by the metropolitan committees, as far back as August 1st, was nearly 30,000 feet of floor or table space, and very nearly as much wall space—the number of exhibitors being 509. Colonel Reid, and Mr. A. Redgrave, have been appointed a deputation to obtain information and make the necessary arrangements for the visit of the working classes to the Exhibition; and a register is now open at 1, Old Palace Yard, Westminster, for the entry of the addresses of parties disposed to afford the necessary accommodation for artizans during their visit.

The Society of Arts has just issued a notice, offering a series of valuable pecuniary and honorary prizes for various treatises on the objects to be exhibited. This list will be found in our last report of the Society's transactions, in the present number.

Mr. Paxton's design is not only fully developed, but a number of the castings are now on the ground; and the "palace of glass" will shortly be in readiness for the reception of those fruits of man's handiwork, to the number of which we are so desirous that Great Britain should furnish its best contributions.

LAW OF COPYRIGHT OF DESIGNS AMENDMENT ACT.

We now propose, in pursuance of our promise of last month, to consider the practical effect of this act, and, at the same time, to give a general view of the several amendments proposed to be made during the past session, in the laws regarding letters patent and the registration of designs.

In our August number, under the head of Patent Law Reform, we mentioned that a bill was then introduced into parliament for the purpose of effecting the abolition of two offices—the Privy Seal and Signet—through which at present letters patent have to be passed; and also giving the Lord Chancellor and the Secretary of State power to make further alterations in the mode of passing letters patent. This bill, we are sorry to say, has not yet been made the law of the land, although we have no doubt but that next session it will become an act of parliament. The late period at which it was introduced into the house, rendered it doubtful, from the first, whether it would get the royal assent during this session or not; and it has shared the fate of many others, from press of matter more important in the eyes of the government.

Had this bill passed, the alterations effected would have saved, in ordinary cases, from two to five days in the time of passing a grant of English letters patent; and the fees payable at the Signet and Privy Seal Offices, respectively, being £4. 7s. at the Signet, in a grant not including the Colonies and Channel Islands, and £5. 0s. 6d. when those possessions are included; and at the Privy Seal, £4. 15s. 6d. with the Colonies and Islands, and £4. 2s. without them, making, in round numbers, an English patent cheaper by £10; but, it must be borne in mind, in no way affecting the cost of Scotch and Irish grants.

Other alterations beneficial to inventors might have been expected from the clause giving the Lord Chancellor and Secretary of State a discretionary power with regard to the mode of passing patents.

The bill first introduced into parliament under the title of the *Law of Copyright of Designs Amendment Act*, was by no means confined to designs within the meaning of the acts for the registration of ornamental designs, and of arts of utility: it included within its provisions, "any new manufacture or invention for which letters patent may by law be granted for the sole making, exercising, vending, or use thereof." As may be readily supposed, in the existing state of the patent laws, there are many and insuperable objections to such a clause as this; and to inventors desirous of an immediate protection, it would have been a great injustice. This, the law officers of the crown soon found out, and the parts of the bill relating to inventions, subject matter for letters patent, were struck out. The practical effect of this bill may shortly be stated to be, a provisional registration for articles coming under the Designs Acts 1842 and 1843, to last a year or eighteen months, if extended by the Board of Trade, the copyrights being protected from piracy by a penalty of from £5 to £30, recoverable either by action in the Superior Courts of Law, or by a summary proceeding before two magistrates. During the continuance of this provisional registration, the proprietor of the design may exhibit it, and sell or transfer his right, and at the expiration may register the design in the usual form. The alterations in the bill do not seem to have been done with very great care, as a clause to the effect, that in any case in which, in the registration of a design, under the Designs Acts 1842 and 1843, it should appear to the registrar that copies, drawings, or prints, as required by those acts, could not be furnished, or that it is unreasonable or unnecessary to require the same, such copies, drawings, or prints, may be dispensed with. As this originally stood in the bill, which also included letters patent, the clause was applicable enough; but in its present form it appears to us to be an utter absurdity.

The secretary of the executive committee of the Exhibition of 1851 has issued a letter to all local committees, informing them of the substance of this act, and also stating that there are reasonable expectations that the lords commissioners of the privy council for trade will be pleased to determine that the rights of provisional registration shall be granted without payment of any fee whatever, to all persons exhibiting any articles at the Exhibition of 1851, entitled to claim protection under the registration acts; and that the commissioners will be enabled to afford facilities to exhibitors to effect such provisional registration in the building of the Exhibition.

The rules to be observed in the provisional registration of designs, and under this act, have not yet been issued; but at any rate, although the fee may be merely a nominal one, it is doubtful to us whether there will be any good effected by it, as it is a question how far registration

under the Non-ornamental Designs Act is useful in nine out of ten of the cases at present registered—an eminent member of the bar having given his opinion that it is impossible to protect any machine, or portion of a machine, under it; and, supposing it so far to be a protection, it can only effect the saving of the government fee of £10. The drawings and specifications must, of course, be prepared as at present; and we are convinced that no really useful improvement, coming under the scope of these acts, was ever lost on the ground of this expense.

We have heard so many promises, session after session, of amendments in the patent laws, without any useful alteration whatever—with the single exception of the enrolment of specifications being confined to one office, instead of three, as formerly—that we cannot help almost despairing of seeing the subject properly treated, and the results brought before the House in a practical form. The report of the government commission, of which we gave an abbreviation in our number for September, 1849, points out very lucidly the evils of the present system; and we think the present age would be indebted to any member who would take the matter up, and persevere in working out the subject, until the alterations, so long demanded, shall be made.

The new stamp act will affect the stamp duties upon specifications to a slight extent, the followers on those deeds being, after the 10th of October next, reduced to 10s., instead of £1 as at present.

THE MECHANIC'S LIBRARY.

Agricultural Chemistry, Sir H. Davy's Elements of, 5s. Sheir.

Britannia and Conway Tubular Bridges, £4 14s. 6d. E. Clarke.

Chemistry, Graham's Library of Illustrated Standard Scientific Works, Vol. I., 8vo. £1 1s. cloth.

Design and Manufactures, Journal of, Vol. III., 8vo. 7s. 6d. cloth.

Materials, On the Strength of, 8vo. 5s. 6d, cloth. T. Tate.

Mensuration, Introductory Treatise on, 12mo. 4s. cloth. J. R. Young.

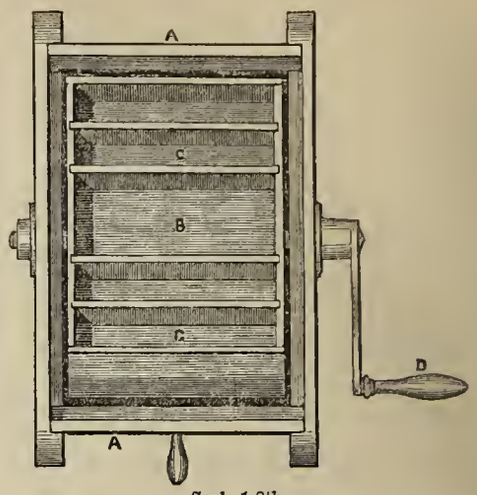
Planetary and Stellar Worlds, The, foolscap, 2s. cloth. Professor Mitchell.

RECENT PATENTS.

CHURNS.

C. J. Anthony, *Pittsburgh, U.S.—Enrolled, December 7th*, 1850.

All improvements of the nineteenth century tend towards the obtainment of increased speed. Even our forefathers' churning mechanism has felt the effect of this anxiety for rapidity, and butter is now made in four or five minutes. The latest improvement—bringing up the rate of production to this point—is that of Mr. Chas. J. Anthony, and patented under the title of "Certain new and useful improvements in the means of treating unctuous animal matter." The churn is of the revolving kind, the dasher-wings having cavities formed in them, so that, in their revolution, they carry down a large quantity of air into the cream, thus effecting speedy oxydation. Our engraving exhibits a plan of the churn-case, with the cover removed, to show the dashers. A A, Is the case, of the ordinary rectangular form; B, is the dasher, which may, if necessary, be formed with several arms, but is here represented with only two. It will be seen that this is simply a flat board, with edges all round on each side, making it somewhat like a species of double tray, the recesses on each face being subdivided into smaller chambers, c c, by transverse bars. The dasher is caused to revolve by the winch-bandle, D, in the usual way—the effect being, that the cavities on the descending side being open to the liquid, carry down with them a quantity of air, forcing it down beneath the surface; whilst, at the same time, the opposite, or rising side of the dasher, causes air to be sucked in and mingled with the cream in the same way.



Scale 1-8th.

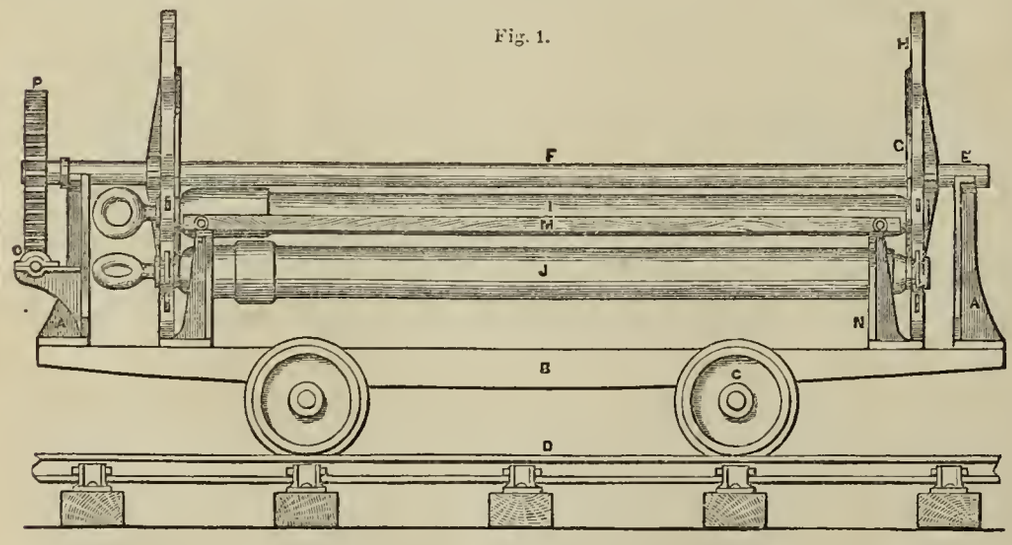
Messrs. R. Gray & Sons, of Uddingstone, to whom has been intrusted the introduction of the new churn into this locality, have repeatedly shown that it is capable of making excellent butter, in from four and a half to twelve minutes. These gentlemen carried off, by its means, the first premium for hand-worked churns, at the late Highland Society's Show in Glasgow. The patentee's claim is for the introduction of cavities into the dasher wings.

REGISTERED DESIGNS.

CORE CARRIAGE FOR MAKING AND DRYING CORES FOR METAL PIPES.

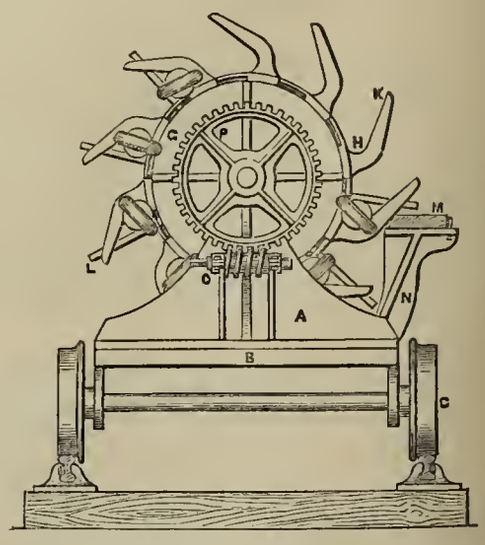
Registered for Messrs. D. Y. Stewart & Co., *St. Rollox, Glasgow.*

Fig. 1.



1-32nd.

Fig 2.



The patent pipe-founding establishment of Messrs. Stewart & Co., at St. Rollox, is noted as a model of its class—for efficient arrangement, and the excellence of its productions. In addition to his ingenious screw-moulding apparatus, the inventor, Mr. D. Y. Stewart, has recently introduced a new plan for making and drying cores for pipes and similar cylindrical articles, which effects a still further saving in the pipe manufacture.

Our engravings represent two views of this "core carriage." Fig. 1 is a front elevation of it in a complete state; and fig. 2 is a corresponding end view. A A, Are two end standards bolted down to the base-

plate, B, which is carried upon the four wheels, C, fitted to run on the rails, D, for convenience of moving. These standards have bearings, E, on their upper ends, for carrying the horizontal shaft, F, which has upon it, near each end, a cast-iron disc, G. These two discs are set at such a distance asunder, as corresponds with the length of the cores intended to be made in the machine; and they are both fitted with a series of bearing brackets, H, bolted or cast on to their peripheries at regular intervals, to carry the core bars, I. Each bearing bracket has an angular entrance-piece, K, for the convenience of placing the necks or ends of the core bars in the recesses of the bearings at H, the bars being retained in their places by keys, L, driven into suitable slots. The drawing exhibits the machine as provided with ten bearings, and in fig. 2, six cores are represented in their places; in fig. 1, one empty core bar, I, and one finished core, J, are shown.

The fixed loam-board, M, for shaping up the external figure of the core, is carried on a pair of brackets at N. Fig. 2, exhibits a core bar as brought round opposite to the loam-board, in readiness for forming the core, which is made in the usual way, the bar being made to revolve in its bearings by a winch-handle. As each core is finished, the discs, G, are turned partially round by the worm, O, gearing with the worm-wheel, P, on the end of the shaft, F, so as to bring the succeeding core bar into the exact position necessary for the proper action of the loam-board. The effect of this arrangement is, that a number of core bars may be placed on the discs, and be coated as often as necessary, without being removed out of their bearings, by causing the discs to revolve on their bearings, E; and the carriage with the cores may then be at once run into the drying stove.

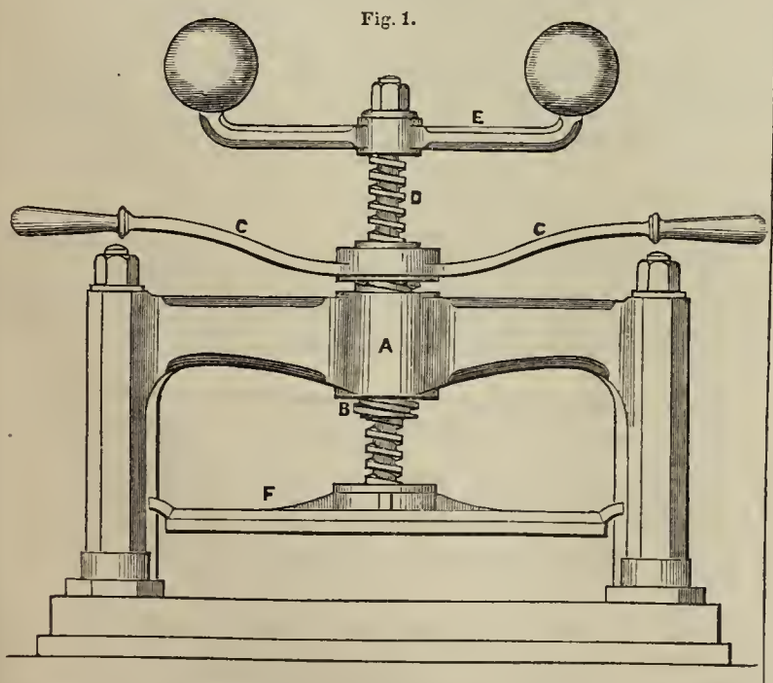
The apparatus is now in extensive use at Messrs. Stewart's works, effecting very great economy in core-making.

DIFFERENTIAL SCREW PRESS.

Registered for R. & W. Howson, *Manchester.*

This is a neat application of Hunter's well-known differential screw movement, proposed and introduced many years ago, for securing both power and a quick movement in screw presses. In working presses with the common single screw, the antagonistic essentials of speed and power confine the screw action within very narrow limits, and prevent the application of a given arrangement to any great variety of purposes. Thus, in compressing cotton, the economy of time requires that, at the commencement of the action, a quick movement should be available, so long as the material presents little resistance,—then, as the compression proceeds, speed must be exchanged for power, to overcome the consequently increased resistance. Again, when the same press is employed on packages of varying bulk, time is lost by the use of the slow compressing movement in the shift of the press table, previous to the actual compression coming into operation. Even in cases where these objections do not apply, if great power is required, we must either make the

Fig. 1.

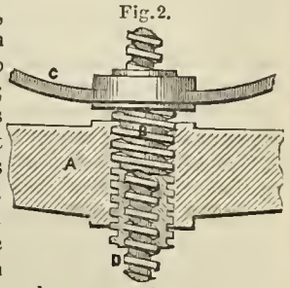


actuating lever excessively long, or the pitch of the screw excessively fine. Both of these resources are applicable only within certain limits; for, on the one hand, the lever becomes unwieldy, whilst, on the other, the threads of the screw may be diminished to an impracticable fineness.

The peculiarity of Mr. Hunter's differential screw, now remodelled by Messrs. Howson, as a movement for copying presses, consists in the combination of two screws, the threads of which are different in pitch. The principle is analogous to that of the Chinese windlass, the barrel of which has two diameters—one giving off, as the other takes on rope; for the pressing surface is urged forward by the screw having the thread of greater pitch, whilst that with the smaller pitch draws it back to an extent corresponding to such pitch. Thus, during each revolution of the screw, instead of advancing the action through a space equal to the pitch of either of the threads, it is really moved a distance equal only to the difference between the two pitches, and the mechanical power is therefore equal to that obtained from a single screw, having a pitch equal to this difference. In this way, power is obtainable to any extent within the practical limits of the difference between the pitches.

Fig. 1 of our engravings represents a side elevation of a "differential screw" copying press, suitable for the counting-house. Fig. 2 is a partial section of the details of the screws. In the cross-bar, A, is fitted a screwed nut, B, worked by the double lever handle, C, and through this nut, the solid screw, D, worked by the upper lever, E, is passed. In setting this press, the upper lever is turned to bring up the plate, F, to the required height; and when the object is inserted, this lever is reversed, until the plate bears upon it. At this point it is that the increased pressure is required, and the lever, C, is therefore brought into operation. When this lever is turned, a differential vertical movement is given to the screw, D, which latter is itself prevented from revolving by friction in the plate, F. Of course the nearer the pitches of the two threads approach each other, the more intense will be the power obtained. The arrangement is considerably neater than the original to which we have referred, and is particularly applicable for bookbinders' presses, where a rapid action, and effective pressure, are both essentials.

Fig. 2.

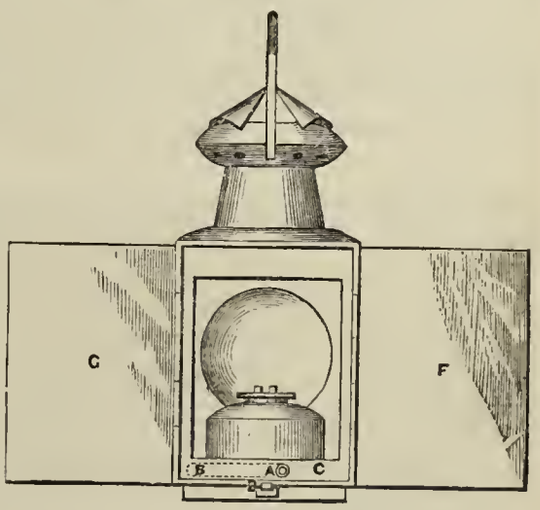


HAND SIGNAL LAMP.

Registered for Messrs. James Thornton & Sons, *Birmingham.*

Many accidents have occurred through the inaccurate action of the ordinary hand signal lamps, having revolving or sliding apparatus for showing and changing the colours, by the colours being only partially turned, so as to exhibit the confusion of two at once. Messrs. Thornton's improvement has for its object the prevention of all chance of such casualty, as well as the securing a larger and more brilliant light.

Fig. 1



Our engraving, fig. 1, represents a front elevation of the lamp, with its two doors open, and fig. 2 is a detail of the door-holding apparatus in plan, on a larger scale.

A, is a peg, attached to the spring, B, and this peg passes through a hole in the frame, G, and presses against the door when the latter is closed; D, is a catch, attached to a spring, E, and holding the door in its place, when closed; but when this catch is depressed below the lower edge of the door, the latter is forced open by the spring and peg, A, B.

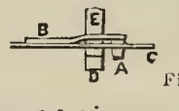


Fig. 2.

The two sides of the lamp are furnished with similar springs and catches; and these sides, together with the front, are glazed with glass of different colours, to suit the signals chosen. F and G are two doors, arranged to shut over and close any two of these three glazed sides—each door being capable of shutting over either its own side, or the front.

Thus, any two sides may he rapidly closed at pleasure, leaving the desired light properly and fully exhibited.

This arrangement is a simple and economical one, and if a glass is accidentally broken, it is easily and cheaply replaced. Guards' lamps are also fitted up on this plan, having the advantage of two reflectors, showing red and white lights.

REVIEWS OF NEW BOOKS.

THE COMMERCIAL HAND-BOOK OF CHEMICAL ANALYSIS. By A. Normandy. 12mo, pp. 640. Woodcuts. London: G. Knight & Sons, Foster Lane. 1850.

"If one of the principal characteristics of our epoch, in a commercial point of view, is the immense progress which every department of productive industry has achieved, it must be admitted that the arts of adulteration and sophistication have more than kept pace with that progress. These arts have invaded the luxuries and necessities of both the rich and the poor—raiment, food, medicine, furniture, the means of life, and the requirements of disease; all that can be mixed, hackled, twisted, ground, pulverised, woven, pressed—all articles of consumption in trade, in manufactures, in the arts, in a word, all that can be made matter of commerce and be sold, is adulterated, falsified, disguised, or drugged."

Such are the introductory lines of Dr. Normandy's preface to a work, which is at once curious, amusing, and practically instructive in pointing out the vast mass of falsifications which permeate the artificialities of the human economy. That the author has not overstrained his case, let any housewife or commercial man answer. Quality is constantly struggling against the offensive attacks of cheapness, and the known extent of modern adulteration is but too sufficient proof of the frequent success of the latter. For a case in point, let us turn to the head "Beer," in our author's copious alphabetical index. In the teeth of the several stringent legal enactments in reference to this universal beverage, providing enormous penalties against brewers who even "have, in possession" only, any of the supposed foreign matters which are presumed to be applicable to the adulteration of beer—

"It is a publicly known fact that carts may be seen bearing the inscription in staring paint, of '——, brewers' druggist.' Such a cart I have myself seen, a few days ago, standing in broad daylight, at mid-day, before a publican's shop or gin-palace. Of course I do not know what the contents of the cart were, nor whether it contained anything, but since the inscription painted upon it indicated the trade of the owner to be that of a *brewers' druggist*, it may fairly, I think, be inferred that the man was a dealer in drugs for the use of dealers in or retailers of beer, spoken of in the Act; that the publican was probably a customer of his, or that endeavours were made to induce him to become one; at any rate, the above facts prove that, since there are beer druggists, there must be beer druggers; consequently, that if the purpose of the Act be useful, the Act itself is powerless, and that some more efficient protection should be resorted to."

What then is the remedy for such egregious rascalities? Are we to borrow a plan from some of our foreign neighbours, and establish a system of medical police, and so crush the evil by direct force? We suspect Dr. Normandy furnishes us with a better reply to the question, for he says "if sophistication could be more readily detected, its practice would become less frequent, and he reduced in proportion to the chance of discovery." From such a view of the matter has arisen the volume before us; and no one can read a dozen of its pages without an involuntary acknowledgement of the success of the author's labours, in at once furnishing so clear an insight into these abominable practices, and so ready a means of detecting them as they occur in practice. Much has been said of the supposed adulterations of Tea—hear Dr. Normandy's notes on this subject:—

"*It is a positive fact* that the bloom is most extensively given to green teas *at home*, in *the warehouses of our own merchants*, by means of magnesia and Prussian blue. It should be known that the seemingly unbroken appearance of the sheet of metal, in which the tea is tightly packed in the chest, is no criterion of its genuineness. Through the hole which is made in the metallic sheet for the purpose of taking sample, the whole of its contents are emptied on a clean floor, and the tea is then mixed with whatever composition it may be thought fit to add, or *worked up* with teas of an inferior quality, or which by themselves would be unsaleable. The repacking is done by re-introducing the tea by small portions at a time, and the workman from time to time carefully puts his foot through the opening which was made for taking sample, and through which the tea was emptied; then grasping a rope fixed against the wall in order to steady himself, and keep his balance without danger of enlarging the hole, he heavily treads the tea down by a series of jerks, until at last a quantity of tea equal to the weight at first emptied is thus pressed into the same bulk or space as before, so that the chest has all the appearance of a genuine importation. Even this trouble of repacking the sophisticated tea is grumbled at by the tea-dealer or merchant, and many attempts have been made to imitate the beautiful seam or soldering by which the sheets of metal are united, which, of course, would enable the sophisticator to repack his teas *after treatment* at once and *off hand*, but the Chinese mode has hitherto baffled the ingenuity of all the tinsmiths and plumbers who have been applied to. The sheet-lead of the package may be easily enough taken asunder, but the re-soldering is another affair, and could not hitherto be even remotely approached.

"Besides the substances which have been named before, black tea is also mixed sometimes with pulverized extract of logwood; this is immediately detected by moistening a small portion of the tea-leaves of the sample with water, and rubbing it gently about upon a sheet of white paper, which, in that case, will be stained bluish-black; moreover, if a portion of the tea, being thrown in cold water, imparts immediately to the liquid a pinkish or purplish colour, which is rendered red by the addition of a few drops of sulphuric acid, it is a sign of the presence of logwood; for genuine black tea produces only, after a time, a golden brown liquor which is not reddened by sulphuric acid. This addition of logwood to black tea is for the purpose of simulating strength by the high colour of the infusion, something like the addition of chicory to coffee. I have met with this kind of adulteration in teas represented as souchong and pekoe.

"The other fixed impurities may be determined as follows: Take 500 grains of the tea under examination, especially the powder which results from abrasion, and incinerate them by small portions at a time in a counterpoised platinum crucible. The ashes, after perfect ignition, should not exceed twenty-seven grains; if in more considerable quantity, the addition of fixed substances may be suspected. If metallic salts, and especially those of lead, are suspected to be present, a porcelain crucible should be used, for a platinum one would be damaged.

"If the tea-leaves have been dusted with *chromote of lead*, the above quantity of tea should be calcined with nitrate of potash, which will leave a greenish residuum, partly soluble in distilled water. The undissolved portion is then treated by hot acetic acid, and evaporated to dryness; the dry residuum is then redissolved in water, and the solution being treated by a current of sulphuretted hydrogen, will yield a black precipitate of sulphuret of lead. This black precipitate being digested in hot nitric acid, will dissolve therein, and the concentrated solution, tested by iodide of potassium, will yield the characteristic yellow precipitate of iodide of lead.

"If tea has been coloured by *salt of copper*, it may be immediately detected by putting a pinch of the tea into a flask with a small quantity of cold water, agitating or shaking it for some time, and throwing the whole upon a filter; a portion of the liquor which filters through being tested with ammonia, will immediately assume a beautiful sapphire-blue colour; another portion of the filtrate being tested with ferrocyanide of potassium, will produce a reddish-brown precipitate of ferrocyanide of copper. These re-actions require sometimes a few hours to be manifested, the quantity of the salt of copper, when present, being always exceedingly small. A bar of metallic iron left for some hours in the filtrate, slightly acidified, will receive a metallic coating of copper, if a salt of this metal is present. Or the ashes of the incinerated portion of which we spoke before, may be treated by a small quantity of nitric acid, and evaporated to dryness. The dry mass is then digested in water and thrown on a small filter. The filtrate may now be treated by ferrocyanuret of potassium, or by ammonia, and hydrosulphuret of ammonia. I think, however, that the addition of salts of copper to tea is rare; at any rate, I never could detect the presence of copper in the various samples in which I looked for that metal.

"After having shaken a certain quantity of tea in a flask with water, the heavy impurities, such as *silica*, *sulphate of lime*, *lime*, *magnesia*, will settle at the bottom; the supernatant leaves may be carefully removed by means of a colander or perforated spoon, and the sediment may then be separated by carefully decanting the water. This sediment should be incinerated, and treated by a small quantity of hydrochloric acid, which will leave the silica and sulphate of lime in an insoluble state. These are separated by filtering, and the filtrate which contains the lime and the magnesia is treated by sulphuric acid and alcohol, which will produce a white precipitate if lime is present. This precipitate, which is sulphate of lime, is collected on a filter, and if the filtrate, being tested by ammonia-phosphate of soda, produces a white precipitate, it is a sign of the presence of magnesia.

"The insoluble portion which was incinerated, and which refused to dissolve in hydrochloric acid, may be boiled in about 500 times its weight of water and filtered; if the filtrate, being tested with solution of chloride of barium, produces a white precipitate of sulphate of baryta, sulphate of lime was present. The residuum which remains altogether insoluble is silica, which may be easily recognised by its grittiness.

"Black tea is sometimes dusted with a little plumbago (black lead), which gives it a shining or lustrous appearance. This impurity remains as a black powder with the silica.

"Tea is sometimes adulterated by an admixture of sloe or elder leaves; the only means of detecting this fraud is by a careful examination of the leaves after they have been untwisted by infusion or moisture; tea-leaves have a different structure, they are more elongated, the edges are more deeply serrated and more delicate than those of the above-named plants.

"Lastly, tea is sometimes adulterated, it is said, by an admixture of tea-leaves which have been already used, and which are dried again and twisted in imitation of the state in which they were originally. This kind of fraud can hardly be detected in any other way than by the want of flavour of the infusion which such tea yields.

"A few months ago, a brownish powder was, and I believe continues to be, offered for sale under the name of *la veno beno*, one quarter of a spoonful of which is described as having the wonderful property of giving to two tea-spoonfuls of tea the strength of four, with an *improved flavour*, besides producing a saving of 75 per cent.!

"*La veno beno* has been represented as being the leaf of a tree, and that tree a climbing plant, well known in the East under the name of *Paun;* which is clearly a much less pretty, and, consequently, a much less *saleable* name than *veno beno*.

"But by whatever name called, *la veno beno* is neither plant nor leaf, but simply a mixture of a very small portion of tea-powder (broken tea-leaves), with an excessively large quantity (upwards of 90 per cent.) of pulverized catechu. Catechu, or terra japonica, is an astringent extract, which is extensively used by tanners and dyers as a substitute for gall-nuts. The extraordinary properties of *veno beno* lie therefore altogether in the contrivance by which a price five or six times greater than its real value, is extracted from the pockets of a *well-advertised* public. In my opinion it has another property, though not an extraordinary one, I mean that of spoiling the flavour of good tea, the fine aroma of which, far from being *improved* by the recommended addition, is, on the contrary, overcome and destroyed by the sweetish-astringent, and peculiar flavour of the catechu. To me, therefore, the addition would prove a clear loss, for, having tried it, I could not drink the infusion, which was thus rendered more rough to the tongue, but singularly vapid and flat, yet the quantity used was below that prescribed. *La veno beno* acts, therefore, upon tea somewhat in the same way as chicory does upon coffee; with this important difference, however, that coffee adulterated, or mixed with chicory, still retains a taste of coffee and is drinkable, even though thus adulterated to a considerable extent; but the aroma of tea being much more delicate and fugitive, any substance having a peculiar taste is sure to predominate, if employed to any notable extent.

"We should, however, be grateful, to a certain extent, to the *inventor* for selling his *veno beno* candidly, though under catching terms, as a tea-adulterating substance, which may or may not be purchased; and we must hope that it will not come into either general or partial use in the grocer's shop, ready mixed with the tea that he retails, as is done with chicory and coffee; though, I am sorry to say, a sample of tea sold by a grocer has already come into my hands which was undoubtedly sprinkled with *veno beno* or *catechu*."

We might fill our number with extracts of a similar character, but we have given enough to answer as a sample of the volume. As to arrangement—it has one excellent quality—readiness of reference. The subjects are given in alphabetical order, and the reader may at once turn to the point to be elucidated. We have only one objection to make—a grave one—but quite remediable by a man of Dr. Normandy's qualifications, when his second edition is demanded—we allude to the tests. These are, too frequently, of a less simple class than is desirable for general use. What is easily and promptly performed in the laboratory, may be costly, difficult, and ineffective in ordinary unscientific hands. If the volume is appreciated according to our opinion of it, an excellent opportunity will hereafter be afforded for the simplification of many of the processes, and for the introduction of others which time will necessarily develop.

A Description of the Electric Indicator. By J. O. N. Rutter, F.R.A.S. Pp. 33. Woodcuts. London: Horne, Thornthwaite & Wood, Newgate Street. 1850.

This is another of Mr Rutter's well-known "little hooks on great subjects," in which class of literature he has been so successful a labourer. The present example of his productions possesses all the features of merit of his earlier ones. It is pointed and pithy in its descriptive details, tells its tale truly, and at the right time. In explanation of the plan on which the "Indicator" is constructed, we cannot do better than copy the inventor's own words:—

"In some convenient part of the house, the master's bed-room, for instance, two boxes must be placed, their respective dimensions being 9 by 5 inches, and 9 inches deep.

"No. 1 contains the voltaic battery, which consists of six small bottles, connected in series and fitted up on the sustaining principle. The battery will continue in operation, without requiring to be touched or looked at, for nine or twelve months, and can be restored to activity for a similar period at the cost of a few pence.

"No. 2 contains the bell, and wheels, and sustains the weights, of an alarum. The catch which takes into the striking-wheel is connected with a lever fixed underneath a vertical helix, hollow in the direction of its axis, and containing an armature moving freely within it. The latter is sustained in its proper place by a permanent magnet. Whenever a current of electricity passes through the helix, the armature is converted into an electro-magnet, and being then instantly repelled by the permanent magnet, it falls upon the end of the lever, liberates the catch, sets the weights in motion, and rings the bell.

"To place the various parts of a house in immediate communication with the apparatus just described, two covered wires are laid, say, along the angles of the passages and rooms, to each of the outside doors and windows, and which are fitted up with a very simple contrivance, termed circuit-plates, and to these plates the ends of the wires are attached. These arrangements being completed, and which are intended to give notice of any attempt at burglary, let us suppose that the doors and windows are shut, and the Indicator set for the night. So long as the guarded parts of the house are safe, everything remains quiet; but if either of the doors or windows be ever so stealthily opened, the electric circuit is completed, quicker than thought the armature falls, and an alarm is given by the ringing of the alarum-bell.

"An additional wire, laid alongside of those just mentioned and connected with thermometers (of a peculiar construction but very cheap) fixed in the passages, rooms, and other parts of the house, constitute the means of giving warning of the first commencement of a fire. The battery and alarum apparatus are used for both purposes at the same time; and with the additional advantage that the fire alarum is in operation by day as well as night, without interfering with the wires of the thief department, which, for convenience, are thrown out of action during the day. The thermometers of which I have spoken, are so adjusted that any sudden rise in the temperature amounting to a difference of 8° or 10° (greater or less as may be desired) beyond the ordinary range of the surrounding atmosphere, causes an immediate alarm to be given. Nor is this all. On the top of the box, No. 1, a magnetized needle is fixed. This instrument forms part of the circuit between the battery and helix, for the purpose of indicating the cause of alarm; the needle pointing to the word 'THIEF,' or 'FIRE,' as the case may be.

"By an easy modification of the arrangements, each story of a house, any particular apartment, or a chest, closet, drawer, or article of furniture, can be guarded independently of other parts; so that, if anything be amiss, not only will the cause of alarm be shown, but the exact locality whence it proceeds will be as distinctly indicated."

If necessary, the wires may be concealed by beadings, or hidden in various ways, so as to afford no evidence of their presence. The invention has been three years in coming to maturity—it is therefore no thought of yesterday—but a "practical ingenuity."

CORRESPONDENCE.

ELASTICITY OF STEAM.

Having observed in the number of your Journal for September, an interesting account, by Mr. W. M. Buchanan, of most of the formulæ which have been proposed for calculating the elasticity of steam at saturation, I beg leave to submit to your notice the formula which I brought forward somewhat more than a year ago, for vapours in general. It is as follows:—

$$\text{Log. P} = a - \frac{b}{t} - \frac{c}{t^2}.$$

Log P represents the logarithm of the pressure of vapour at saturation; t represents the *absolute temperature*, which is found by adding 462°·28, and the temperature as reckoned in the ordinary manner, if Fahrenheit's scale is used; or 274°·6, if the centigrade scale is used.

a, b, and c, are three constants, to be determined from three experimental data for each fluid.

When the pressure is expressed in inches of mercury, and the temperature in degrees of Fahrenheit, the values of these constants, for steam, are as follows:—

$$a = 6{\cdot}426421 \quad \log. b = 3{\cdot}4403816 \quad \log. c = 5{\cdot}5932626.$$

The inverse formula, for calculating the temperature from the pressure, is—

$$\frac{1}{t} = \sqrt{\frac{a - \log. \text{P}}{\cdot} + \frac{b^2}{4c^2}} - \frac{b}{2c},$$

For steam, and for degrees of Fahrenheit, we have

$$\frac{b}{2c} = 0{\cdot}0035163 \quad \frac{b^2}{4c^2} = 0{\cdot}000012364.$$

The agreement of this formula with M. Regnault's experiments throughout their whole range, from $\frac{1}{2200}$ of an atmosphere up to 28 atmospheres, is all but perfect.

A detailed account of this formula, and of its comparison with experiment, for the vapours of water, alcohol, ether, turpentine, petroleum, and mercury, is published in the Edinburgh New Philosophical Journal for July, 1849; and in a paper on the Mechanical Action of Heat, in the first part of the twentieth volume of the Transactions of the Royal Society of Edinburgh, I have stated the theoretical views by which the formula was suggested to me, and given a table computed from it, by means of which the density of steam of a given pressure, and *vice versa*, can be calculated for all pressures, from $\frac{1}{2200}$ atmosphere up to forty-six atmospheres.

W. J. Macquourn Rankine.

57 *West Nile Street, Glasgow, 6th Sept.*, 1850.

[The author of the paper to which Mr. Rankine refers, having mentioned at the time of going to press with the August part, the fact of his curtailment of the article in question, we submitted Mr. Rankine's note to him, and he has in consequence furnished us with the portion then suppressed, which we now append.—Ed. P. M. Journal.]

I did not include Mr. Rankine's formula among those enumerated in my article of last month, on the forms proposed to connect the elasticity of steam of maximum density with its temperature, not that I wished to ignore its existence, but because it seemed, on account of its great accuracy, and the wide extent of the range through which it represents the experimental results obtained by M. Regnault, to require more than a passing reference. In my article, *as written*, Mr. Rankine's equation was not only referred to, but given *in extenso*, and was withdrawn along with some other matters, only in consequence of the length to which the article had unexpectedly grown. I shall here replace that portion of the original draft which relates to the subject in question: the partial repetition thus introduced is not seriously objectionable, and allows the passage to retain its integrity. The passage stood as follows, with the exception of the parentheses, which are now interpolated: the notation is from the published article in the *Edinburgh New Philosophical Journal:*

"The rules employed by M. Regnault (to connect the temperature with the pressure of the steam in a state of saturation) are chiefly constructed on the model proposed by M. Biot; but although greatly more laborious, they do not appear to be much, if in any degree, more exact than those constructed on Professor Roche's model; and he has not succeeded in forming any rule so exact, over the whole range of his graphic curve, as those given above (page 131). The wide range, indeed, over which those rules extend, and the great accuracy which they exhibit within the limits for which they are determined, seem to indicate that they contain at least the first terms of the absolute law. This supposition is further countenanced by the circumstance, that the same form expresses better than any other the tension of the vapours of some other liquids, as ether and alcohol. In all probability the formula ought to contain higher powers of the temperature than the first: that it ought to take some such form as

$$\text{F} = x\, \text{A}^{\alpha + \beta t + \gamma t^2 + \ldots^{t}}$$

M. Bary indeed applied the formula in this form, continued to the third power of t, to vapours long ago; and Mr. W. J. M. Rankine has very recently determined the constants for it in the form

$$\log. \text{P} = x - \frac{\beta}{t + \varkappa} - \frac{\gamma}{(t + \varkappa)^2}$$

for steam and some other vapours.* Mr. Rankine's rule for steam extends over the whole curve determined by M. Regnault for the air-thermometer, and regard being had to the distance and difference of the extreme ordinates, it is the most exact hitherto published. His constants for steam are the following:—

$\varkappa = 462{\cdot}28$ supposing the boiling point of the thermometer to have been adjusted under a pressure of 29·922 inches of mercury, so that 180° F. may exactly coincide with 100° C.

$= 461{\cdot}93$ supposing the boiling point to have been adjusted under a pressure of 30 inches of mercury, so that 180° F. = 100°·0735 of the Centigrade scale.

Log. $\beta = 3{\cdot}4403816$ when $\varkappa = 462{\cdot}28$.

$= 3{\cdot}4400625$ $\varkappa = 461{\cdot}93$.

$x = 4{\cdot}950433$ for atmospheres of 29·922 inches of mercury = 14·7 lbs. on the square inch.

$= 4{\cdot}949300$ for atmospheres of 30 inches of mercury.

$= 6{\cdot}117817$ for lbs. on the square inch of surface.

* See *Edinburgh New Philosophical Journal*, vol. xlvii. p. 28.

= 6·426421 for inches of mercury.
= 7·831247 for millimètres of mercury.
= 4·964658 for kilogrammes on the square centimètre.

The inverse formula for calculating the temperature when the elasticity of the steam is given, takes the form

$$t = \frac{1}{\sqrt{\left\{\frac{x - \log. P}{\gamma} + \frac{\beta^2}{4\gamma^2}\right\}} - \frac{\beta}{2\gamma}} - x$$

in which $\frac{\beta}{2\gamma} = 0{\cdot}0035163$, $\frac{\beta^2}{4\gamma^2} = 0{\cdot}000012364$ } for $x = 462{\cdot}28$.

$\frac{\beta}{2\gamma} = 0{\cdot}0035189$, $\frac{\beta^2}{4\gamma^2} = 0{\cdot}000012383$ } for $x = 461{\cdot}93$.

The operations of this inverse formula are much increased, but in point of accuracy it is generally very satisfactory. Extending from — 22° to 446° of Fahrenheit's scale, it is the most exact of all the formulæ hitherto proposed for the same width of range. It is, however, much more tedious, especially in the inverse form; and is, at least, *not more* exact than the simpler rule given above (p. 131) between the same limits.

To this I would only here add, that Mr. Rankine's rule is much more satisfactory above than below 212°, and that the differences, at the very low temperatures, are *relatively* much greater than we are warranted in attributing to errors of observation. Indeed, when much exactness is desirable in calculations approaching the lower extremity of the curve, no rule extending through a very wide range ought to be accepted. This, at least, is the conclusion to which I was led by repeated attempts to include the portion of the curve from 120° downwards in a single expression: none of the results were, in my opinion, quite satisfactory. The errors, it is true, were, by some of the expressions, very small, when taken absolutely; but they were *relatively* too large to allow it to be supposed that a proper equation to the curve had been obtained.

It is scarcely necessary to state, that the model of Mr. Rankine's rule differs from that upon which mine is based, in its containing a fourth term: its primitive form is

$$F = a\left\{b\, A^{\frac{1}{x} + t}\right\}^{x} - t.$$

The fundamental character is, therefore, the same."

I have not seen Mr. Rankine's paper in the Transactions of the Royal Society of Edinburgh, and am, therefore, not aware what peculiar theoretical views may have led him to adopt this particular form of equation.

W. M. Buchanan.

SIMS' HORIZONTAL DOUBLE-EXPANSION ENGINE.

In your scientific and truly practical *Journal* of July, No. 28, is a description, with illustrated drawings, of a very clever compound horizontal double-expansion engine, of 35 horse power, by James Sims, Esq., an engineer, who has earned considerable reputation in constructive detail. This engine is, I think, one of his most ingenious arrangements, and, with your permission, I will make an attempt at a calculation of its power and consumption of coal. I have assumed the cylinder pressure at 25 lbs. per square inch, a very general pressure in this neighbourhood, and one which may be adopted by the most timid without fear of explosion; the size of the small cylinder, 16 inches diameter; large or expansion cylinder, 32 inches diameter, with a stroke of 3½ feet—the ratio of the areas of the two cylinders being as 4 to 1, as in the drawing and description; the speed of the piston, 228 feet per minute—although we have examples of engines running with a speed of 340 feet per minute with economy and greatly increased powers; area of each cylinder in square inches × pressure of steam per square inch × speed of piston in feet, and the product divided by 33,000 lbs. one foot high per minute, per horse power, will give the computed power of each cylinder:—

Small cylinder, $\frac{201 \times 25 \times 228}{33{,}000} = 20{\cdot}9$, or say 21 horse power.

As there is a constant vacuum between the two pistons, and alternately at the back of the large piston, it will, I think, be evident that this is the power of the small cylinder—the steam being admitted until nearly the termination of the stroke. During the expansion on the given conditions of the respective cylinders, the mean pressure of the steam would be about 6 lbs. per inch on the large or expansion piston, with a reaction, probably, of about one pound per inch on the small piston:—

Area of expansion cylinder, 804 square inches.
Area of small piston, 201 — 6 lbs. per inch.
Opposing pressure, 1 — 4,824
201 — 201

Power of large cylinder, $\frac{4{,}623 \times 228}{33{,}000} = 31{\cdot}93$ horse power.
Power of small do., ... 21·00

Absolute power of the compound cylinders, 52·93 horses.
If we deduct one-third for friction, 17·64 do.

Effective horse power, 34·29 or say 35 horse power.

To ascertain the quantity of coals this engine will consume, it will be requisite to determine the quantity of water to be evaporated to produce a sufficient supply of steam, which can be done as follows:—

$$\frac{\text{The area of the small cylinder in sq. in.} \times \text{by the speed in feet per in.}}{\cdot 144} =$$

capacity of small cylinder in cubic feet per minute, $\frac{201 \times 228}{\cdot 144} = 318$ cubic feet—representing the space occupied by the action of the piston in one minute; but in this improved engine it will be perceived that the steam is only required every alternate stroke: consequently, the quantity required is only one-half of this, or say 160 cubic feet; and if we add thereto one-tenth more, for the steam passages and clearance, we shall find the boiler must supply per minute 160 + 16 = 176 cubic feet, under a pressure of 25 lbs. per square inch, and, per hour, 176 × 60 = 10,650 cubic feet of steam.

One cubic foot of water converted into steam of an elastic force of 25 lbs. per square inch, will occupy, in the shape of steam, about 963 times its original volume: consequently, the 10,560 cubic feet that will be requisite per hour will be the product of $\frac{10{,}560}{963} = 11$ cubic feet of water per hour—hence 11 × 62·5 = 687 lbs. avoirdupois of water per hour, according to the experiments of Mr. Wickstead and others. One pound of coal will evaporate 9 lbs. of water; the hourly consumption would be $\frac{687}{9} = 76{\cdot}3$ lbs. of coal per hour, and $\frac{76{\cdot}3}{\text{b. p. } 35} = 2{\cdot}18$ lbs. of coal per horse power per hour.

Numerous causes might produce a consumption of 2½ or 3 lbs. of coal per hour; the difficulty, I think, would be the reduction of the coal consumed to the quantity theoretically calculated as sufficient. Instead of low-pressure engines, the proper standard for comparison for this engine would be Watt's engine working expansively—both using similar boilers and coal.

In your notice of this engine, you state her as 35 horse power, the consumption of coals under 6 cwt., which would be 1·92 lbs. of coals per horse per hour—a very small consumption in practice, and which must ultimately bring this principle of steam-engine into general use.

John Johnson, Jun.

Hunslet Road, Leeds, September, 1850.

WIRE ROPE RAILWAY SIGNALS.

We believe you will find it rather difficult to ascertain who was the inventor of working railway signals at a distance by means of *a rope*—the plan having been in use in colliery railways in this part of the country for certainly more than thirty years. But we believe we were the first to suggest the use of, and to make, our Patent Wire Cord for signals in 1840.

The longest we have made was 5,000 yards.

R. S. NEWALL & Co.

Patent Wire Rope-Works, Gateshead, September 11, 1850.

DIMENSIONS FOR A MINIATURE STEAMER.

I have just completed a small engine, with a pair of cylinders 3 inches diameter, on the high-pressure oscillating system, to work with steam at 45 lbs., which, I calculate, will give a power of two horses. I wish to know what size of screw propeller to put on the shaft, which makes 440 revolutions per minute; also, the pitch of the screw. The shaft is placed at a distance of 3¾ inches from the boat's bottom. I should also be glad to know what size of boat, in length, breadth, and depth, it would require. The engines occupy a space equal to 27¼ inches by 29½ inches.

G. Culleme.

Gateshead-on-Tyne, September, 1850.

THE BRITISH ASSOCIATION AND RUTHVEN'S STEAM-SHIP PROPELLER.

Mr. Ruthven has had the misfortune to expect that it would be for the advancement of science and his own interest, to exhibit a model of his propelling apparatus before the savans who composed the Mechanical Section during the late diet of the British Association in Edinburgh. I learn from your excellent summary of their proceedings, in your number for this month, that Mr. Ruthven has been exhibiting his model as aforesaid, and that the meeting, through their president, was graciously pleased to award him a vote,—viz., a word of advice, upon the necessity of submitting his plans to the scrutiny of somebody knowing in the mathematics of hydraulics. Now, I rather like this condescension on the part of the president: the unaffected honesty of the advice is really refreshing amidst the accumulations of imposition and cant with which one meets everywhere. The proposed object of the Association is to advance science, and science applied: to do so, the Association necessarily takes cognisance of all that is brought before it; that is, of all that it deems worthy of admitting to an audience; and if such cognisance means anything, it means that the subjects formally introduced and discussed before the meeting, should receive formal judgments, and be dismissed with tangible expressions of approval or condemnation. Consequently, when we found a promising application of a purely scientific principle to practical purposes, turned to the right-about with a reference to some other and competent authority for a decision—though it may, for a season, be damned by indifference, the conclusion operated most tellingly on the members present, and proved them to have been but blind leaders of the blind. The foppery of science has been illustriously displayed: there was the tinkling of cymbals, and the patronising smiles of polished assurance, and Mr. Ruthven left them with the pleasing information, that as neither they nor he understood what they were talking about, he had better tack about with his boat in search of "some investigator versed in the mathematics of hydraulics."

Assuming that Mr. Ruthven does not understand his subject, allow me to supply the expressed want of the British Association, by a reference to the published opinions of the first authority on water power in Scotland, on the cognate subject of water-wheels;* and, in my humble way, I shall undertake to apply his conclusions, and bring them to bear upon the propeller.

Imprimis, then, while discussing the "mathematics of hydraulics," with reference generally to water-wheels, our author finds that when water is made to act by impulse; that is, when, instead of descending vertically, it is made to descend upon an inclined plane, and strike with all the velocity which the fall can produce upon the float-boards of an undershot wheel, "the water, on arriving at the lowest point of the descent, will have acquired an impetus sufficient to enable it to ascend an opposite incline, of proper form, to the height from which it descended. The height (h) of fall producing the velocity, and the velocity (v) produced, will have the relation $h = \frac{v^2}{2g}$; and the momentum will be represented by $w\,\frac{v^2}{2g}$, w being the weight of the water. This being the total momentum present, the question is reduced to finding the portion of it transferred to the wheel." Supposing the floats were hung radially, and closely fitting the water-course, our authority proceeds to state, "that the motion of the floats must be less than the attainable velocity of the water;" for were they to move with an equal velocity, they could derive no impulse from it, and would be retarded by the fluid if they moved with a higher velocity. But if the floats recede before the impulse of the fluid with any given velocity, v, the intensity of the impulse will be correspondingly lessened; for the recession is manifestly equivalent to an equal reduction of the velocity of the current. The effective velocity will therefore be reduced to V—v; [V being the absolute velocity of the water at the moment of impact,] and as the water must escape with a velocity not less than v, the momentum transferred to the wheel will therefore not exceed

$$\frac{w}{g}(\mathrm{V}-v)v.$$

This the writer renders apparent by observing that $\frac{w}{g}$ is the *mass* of the water which acts in the unit of time with the velocity V—v; the product $\frac{w}{g}(\mathrm{V}-v)$ is therefore the pressure with which the wheel is impelled through the space of v feet a second; but the mechanical effect is the product of the pressure into the space $= \frac{w}{g}(\mathrm{V}-v)\,v$.

In this expression, v is the only variable quantity. If $v = o$, the expression vanishes, and the effect is *zero:* for a machine which does not move, transmits no power, whatever may be the pressure upon it. If $v = \mathrm{V}$, the expression also vanishes, and the power transmitted is nil; for when the wheel moves with the same velocity as the water, it can receive no impression from it, and can only move at that velocity when the load, including all the active and passive resistance, is nothing. Now, between the extremes, $v = o$ and $v = \mathrm{V}$, there will be a value for v for which $(\mathrm{V}-v)\,v$ is a maximum. But if a mean be divided into two parts, the product formed by multiplying together those parts will be the greatest possible when the factors are equal, and, therefore, in the present instance, when

$$\mathrm{V}-v = v, \text{ whence } v = \tfrac{1}{2}\,\mathrm{V}.$$

That is, the effect yielded by the wheel will be a maximum when the floats have a velocity equal to half the velocity of the current, equal to 50 per cent. of the whole power of the water.

The writer proceeds to indicate the general principle of the "re-action" of water. He agrees with us that all the weight which would be necessary and sufficient to prevent our favourite vessel, the tall one, from receding in a direction opposite to that in which water is allowed to escape through a lateral orifice, is that of a column of water equal in length to twice the head of water over the orifice, and having an area of base equal to the area of the opening. I proceed, therefore, to quote his observations on Barker's mill, and he at once recognises the same principle of double pressure of re-action when the machine is held at rest, while the water escapes by the orifices at the extremities of the arms. He proceeds to the consideration of the circumstances of the machine in motion, when centrifugal force is brought into action. As, however, the discussion of this principle is beside the line of argument now before me, I shall pass on to the general formula deduced by the author; and he finds that the power transmitted by Barker's mill is represented by the formula

$$\frac{w}{g}\left(\mathrm{V}-v\right)v.$$

in which w is the weight of water discharged in a second; V, the velocity of the issuing jets, and v the absolute velocity of the machine; whence he observes, that "the theoretical rule thus agrees with that established for wheels which derive their efficiency from the impulse of the stream, thereby verifyng the doctrine, that action and reaction are equal." Now, here it must be observed, that the value of V is affected largely by the centrifugal force with which the water is actuated, so as virtually to increase the head of pressure under which the water is discharged. The velocity of maximum effect has not been derived theoretically by the author. He states, however, that in practice, $v = 8\sqrt{h}$, is found to be the most favourable velocity of the extremities of the arms of the machine. And he recapitulates the results of experiments made by himself and Mr. Whitelaw, from which it appears that a maximum effect of 78·3 per cent. was obtained. In general, 76 per cent. is readily obtained from machines of good construction, as attested by several referees, whose reports have been published in Mr. Whitelaw's accounts of his water mills.

Thus, Mr. Editor, I have done all that is to be done in the way of quoting the opinions of men versed in the mathematics of hydraulics, as the special subject of the reaction-wheel. (You perceive, I retain the word "reaction.")

To apply the foregoing considerations to Mr. Ruthven's propeller is the business of a few lines. It is distinguished from Whitelaw's propeller, in the eye of theory, only in degree. It is one arm of a Whitelaw's mill, of which the radius is infinitely large, and therefore the designed path of the propelling jets becomes a straight line. The centrifugal element thus disappears in estimating the efficiency of the propeller: a circumstance rather in its favour, as the head of pressure is the sole source of power, and the power therefore operates more simply. The speeds at which it may appear expedient to eject the issuing water in Ruthven's application, are matters for experimental investigation. There is no inconvenience to be found on this score, as very small and manageable "jets" are practically applicable, even for the best conditions of discharge. It is also to be observed, that considerable variations of relative velocity are permissible with but trifling deductions of effect.

As to the mode of generating the required head of pressure, this is a question of detail which Mr. Ruthven will better understand than I do. I do not, however, distress myself on this point, as the necessity of generating the power to be employed is common to all modes of marine pro-

* Engineer and Machinist's Assistant, 2d edition.

pulsion, and of course gives rise to a deduction of useful effect common to all. And as the paddle and the screw usefully employ a theoretical maximum of only 50 per cent. of the power transmitted to them, it is plain that Ruthven's propeller, which should yield at least 76 per cent. practically, is destined to shoot ahead of them all.—Q. E. D.

Blessed are they that expect nothing, for they shall not be disappointed. Let Mr. Ruthven carry out his designs, and exhibit them on the broad impartial field of the wide ocean, where the evidence of experience will blunt the edge of all sarcasm—where he will find that nature is not careful to maintain old established interests in the face of his beautifully simple, and scientifically perfect system of propulsion.

September, 1850. D. K. C.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH METEOROLOGICAL SOCIETY.

The formation of a new Society under this title, is an important event in our scientific history. If the exertions of the hereafter are as vigorous as those of the present, it cannot fail to give a decided impulse to the systematic study of atmospheric phenomena. We append the opening Address of the promoters—from which, our readers will see there is no want of working hands of eminence.

"The science of Meteorology has remained up to the present time without that assistance which is given to many other branches of physical inquiry by associated bodies. Its successful study, however, requires the combined efforts of numerous observers, steadily following a well-concerted plan, employing the same class of instruments, and reducing their results in the same form. In order to secure these advantages, it has long been a matter of consideration whether the benefit of association, already found to be so important in advancing other physical sciences, may not be made available to encourage and support that of Meteorology.

With this intention a Society has been formed, to be called the "British Meteorological Society." This proposal has been most cordially entertained; above one hundred gentlemen have become members; and the Council which has been formed, in making this announcement public, hope that others interested in the advancement of this science, will either join it as members, or extend its sphere of usefulness by contributing truthful observations.

The increased attention which has been paid within the last few years to the construction of instruments, and the determination of their index-errors, to the examination of observations, and their uniform reduction, combination and prompt publication of the results, has induced, in widely distant parts of the country, a number of trustworthy observers to become practical Meteorologists, and diligently to observe those atmospherical phenomena, which have been hitherto considered adequate for determining average values, the character of a climate, and the influence it exerts on mortality and disease.

It is desirable that the same facility of obtaining truthful instruments should be given to all men of science, to scientific travellers, to agriculturists, to naval and military officers, to medical men, to practical chemists, and, in short, to all persons who will use instruments with accuracy and energy; and it is presumed that this object will be attained by a Society of Meteorologists, founded upon the best model of other scientific and literary institutions.

A large number of valuable thermometrical, barometrical and other observations have been collected by gentlemen in different parts of the country, and the mean values of many of them have been published; but owing to the expense attendant on their arrangement, classification, reduction and publication, no use has been made of many simultaneous observations, and many journals of this description will be lost, while others will remain in obscurity or be deprived of value to all useful purposes, unless collected and classified by a Society of this description; one of whose objects will be the collecting of manuscript observations, from which may be formed a connected series of valuable facts, which will answer both for present use and future reference.

The reduction of observations and the combination of their results are most laborious; but observations without reduction and combination are of little value, and of no value whatever in determining the elements of the science.

Amongst the objects of this Society, therefore, will be the reduction of observations and combination of results, as far as their funds will allow; nevertheless, it is to be hoped that the emulation which will naturally be excited amongst observers to supply observations producing the best results, will also induce them to reduce their own observations, as far as they may be able to do so. With the view of stimulating observers to perform this work, this Society will publish from time to time useful tables to facilitate the reduction of observations.

The Council fully trust, that whilst the establishment of the British Meteorological Society will be the means of diffusing throughout this country a philosophical spirit of inquiry, and of inducing a more general employment of trustworthy instruments, and the carefully noting and submitting for comparison the observations thus made, it will also have a more extended influence. By facilitating a comparison of the observations of its own members with those made in other countries, meteorological phenomena will be better traced, and thus effects more satisfactorily and surely referred to their true causes. A remarkable instance of the want of connecting observations has been so recently rendered obvious, that it may not be without its use briefly to refer to it here. In the 'American Traveller,' published at Boston on April 6, 1850, and recently received in this country, is a paper by W. Cranch Bond, Esq., of Cambridge, United States, in which he speaks of the great atmospheric wave which was passing over England from the 1st to the 18th day of February 1849, the mean reading of the barometer during this interval of time being fully half an inch above its average value; and when the crest of the wave was over Greenwich, the reading of the barometer at the level of the sea was 30·90 in. The base of the wave at this time seems to have been in extent just equal to the distance from England to America; for, on the same day that it completed its passage at Greenwich, it was first felt at Boston, and it was seventeen days passing over Boston, as it was with us. Its motion, therefore, must have been about 170 miles daily. The reduced readings of the barometer during the time of the passage of the wave at Boston, and its extreme readings, were identical in value with those at Greenwich; at present we cannot follow this very remarkable heaping up of the air, from the want of observations at different places.

Another object of this Society will be, to avail itself of every opportunity of establishing observatories in those parts of the world where none are at present in existence.

Other beneficial results to be expected from a Society of this kind, are the diffusion of a spirit of inquiry concerning the use of instruments, the practice and extension of meteorological researches, and the encouragement of mutual information among its members.

Before concluding this address, it may be as well to sum up the principal objects contemplated by the British Meteorological Society. They may be thus briefly stated:—

1. A collection of correct manuscript observations.
2. The publication of tables.
3. The reduction of observations to useful results.
4. A collection of all observations of the same phenomena.
5. The formation of a repository to which observers may consign the results of their labours.
6. The distribution of meteorological papers.
7. The examination and correction of meteorological instruments.
8. The encouragement and promotion of meteorological science.

As the income of the Society will depend upon the number of its members, it is impossible *at present* to foresee the extent to which the Society may be able to attain these objects. The following seem, however, to be the proper uses to which its funds should in the first instance be applied.

1. The ordinary expenses attending a Society of this kind.
2. The payment of clerks to arrange and classify the manuscripts, the books, &c.
3. The payment of computers to reduce observations.
4. The printing of papers, tables, &c.
5. The formation of a library.
6. The payment of persons for the examination and comparison of instruments, &c. &c.

The laws which govern meteorological phenomena, which are, in fact, the laws of climate, may be less obvious than those which regulate and harmonize the motions of the heavenly bodies; but the more minute investigation of them, which is now systematically proposed, will tend to show, that in this, as in every other branch of natural knowledge, immediate and important benefits will result from the inquiry; and nothing has a greater tendency to enlarge our views of the wisdom and beneficence of the Creator, than a more accurate knowledge of the laws by which the universe is harmonised and regulated.

The Council, aware that many difficulties have to be surmounted, yet fully trust, by steadily and assiduously following out the principles above laid down, success will attend their efforts, and that ere long the British Meteorological Society will be justly classed amongst those which are certainly promoting natural knowledge."

LIST OF OFFICERS.

President—Samuel Charles Whitbread, Esq., F.R.A.S.

Vice-Presidents—General Sir Thomas M. Brisbane, Bart., K.C.B., F.R.S. Lord Robert Grosvenor, M.P. Luke Howard, Esq., F.R.S. Hastings Russell, Esq., M.P.

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MONTHLY NOTES.

Carrick's Self-Acting Meter.—In this meter the water is introduced through a pipe, shut at the end by a projecting flange, but having ports for the passage of the water. At the lower end of these ports another flange passes round the pipe. An outer case or cover is ground to face the flanges closely, so that, when the cover is up, the supply is shut off. This cover is attached by a chain to the end of a beam, whose fulcrum is above the water line in the meter. From the other end of this beam a perforated bucket is suspended through a boxed-in space, and hangs under the lower end of a syphon which passes up said space, and through its side, down to the bottom of the meter. When the flowing water reaches the bend of the syphon the bucket is filled, and its superior weight shuts the valve, so that no water is let in till the meter is emptied. The bucket ultimately empties itself through the perforations, and being *now* lighter than the valve cover, the latter descends, and the supply is resumed. The cistern is immediately under the meter, and is governed by a float and stop-cock to prevent overflow. The indication of the quantity delivered is taken from the movement of the beam—the *unit* being the *number* of gallons the meter is constructed to contain.

IRON ROOF AT THE LIVERPOOL TERMINUS OF THE LANCASHIRE AND YORKSHIRE RAILWAY.—This roof has been erected under the superintendence of John Hawkshaw, Esq., engineer to the Lancashire and Yorkshire Railway, by Messrs. Fox, Henderson, & Co., engineers and ironfounders of Birmingham. The roof covers five lines of rails and three platforms, and a carriage road twelve yards wide, in one span, having no columns nor supports besides the outside walls; the span varies from 136 feet to 128 feet, and the total length is 638 feet. The total area thus covered is 83,457 feet. The material used in the construction of this roof is entirely iron. The framing consists of a series of trussed principals, placed at intervals of eleven feet from centre to centre; these principals are attached to the outside walls by cast-iron bed plates or shoes, the whole of which, upon one side of the roof, are so constructed that the principals may contract or expand freely from variations of temperature. Immediately over the principals are fixed wrought-iron purlines, which support the covering; this covering is of corrugated sheet-iron, galvanized. The roof is both lighted and ventilated along the ridge by four continuous rows of large skylights, and two rows of louvres; half the light is distributed along the ridge, and the remaining half is equally distributed at the eaves; the total area of light admitted being equal to one-fourth of the entire area of the roof. Considering the immense extent of sheet-iron in the covering of the roof, it was deemed advisable to make expansion-joints at various places in the corrugated iron. This principle was also applied to the skylights, and the entire length of roof is thus divided into several portions, which can contract or expand without impairing the efficiency of the work, as being weather-proof, or destroying its unity of appearance.

ON THE PRODUCTION OF COLOURING MATTERS FROM CHROMATE OF LEAD AND MURIATE OF AMMONIA.—Our correspondent, Mr. Smith of Blackford, has recently read a paper before the Royal Scottish Society of Arts, showing that when chromate of lead is mixed with muriate of ammonia, and subjected to the action of heat, a substance is obtained of a different colour from either of the matters used. If the proportions of the substances be varied, and different degrees of heat applied, distinct colours and tints will be the result. Thus, when five parts of chromate of lead, and one part of muriate of ammonia, are heated to redness in a crucible, a red colour is obtained. A blue colour is formed by heating ten parts of muriate of ammonia, and one part of chromate of lead, to ebullition, and a green is produced when the last mixture is heated nearly to redness. By employing various proportions of the substances, and different degrees of heat, a great variety of tints are formed—scarlets, oranges, browns, blues, purples, greens, yellows, and others. These substances appear to be a series of compounds formed by the agency of calorie, the constitution of the bodies which form them, combining in different proportions; or it may be that they are effected by the action of caloric in the same way that the peroxide of mercury turns yellow, binoxide of mercury black, and the salts of cobalt blue, on being heated—only that the modifications of the former are permanent, while those of the latter are transitory. Independent of the interesting phenomena which these experiments exhibit, we are of the opinion that they may be successfully applied to the arts—such as in oil and water-colour painting, and in papier-mâché works—as they are both durable and beautiful. When they are taken from the crucible they present a dull appearance, some being nearly black; but, after a short exposure to the ordinary temperature of the air, they assume a bright tint.

THE ELECTRIC INDICATOR.—Mr. Rutter—whose excellent practical works in connection with the manufacture and use of gas have more than once been noticed in these pages—has recently patented what he terms an "electric indicator," or "fire and thief alarm." The indicator consists of a small apparatus, placed in a bed-room, or other convenient situation, having wires passing from it, to communicate with the different rooms and passages to which protection is to be extended. If anything occurs in any localities thus protected, by which the temperature is raised above the ordinary limits, the apparatus at once gives the alarm. Similarly, if any protected door or window is opened, a corresponding signal results. We have, in another place, detailed the plans, so that our readers may judge how far the arrangement is practically applicable.

NOVEL APPLICATIONS OF GUTTA PERCHA.—A graphic little sketch has been recently issued by the enterprising Gutta Percha Company, illustrative of the application of gutta percha tubing as a hearing apparatus for the deaf in churches. A funnel of the material is placed either inside the pulpit, quite out of sight, or, if ornamented, in front of the pulpit, so as to come immediately beneath the desk. A tube from this funnel then passes downwards beneath the floor, and is carried along the aisles, with branches off on each side to the pews occupied by people of defective hearing. The termination of the tube is all that appears in sight, and the ivory ear-piece being applied to the ear, the slightest whisper of the preacher is clearly heard. The war which the new material wages against the dominion of leather, may be judged of from a report by Lieut. Rouse, the superintendent of the Greenwich Hospital Schools. He commenced his test at the beginning of the year, by soling 800 boys' shoes with it. After such a trial, he may be deemed a competent judge. He states his conviction that soles of this kind are far more economical than leather, and that their power of repelling wet has not been over-estimated. Lead water-pipes are rapidly being superseded by this substance; and we find that, at the Bristol Vitriol Works, the same fate has attended the costly leather pump-buckets, at one time universally employed for the transmission of the acid. At the suggestion of Mr. Wilson, of Price's well-known Patent Candle Works, it has also met with an application as a lining material for muriatic acid casks, for using instead of the fragile carboys. These are a few of the more lately-discovered uses of this substance, the employment of which is extending so astonishingly fast, that we shall soon be unable to do anything, or go anywhere, without meeting with it in one or other of its countless forms.

LOWE'S STENCH-TRAP GRID.—This ingenious contrivance combines in one simple apparatus, a sewer grating, an effluvia, a sediment, and a vermin trap, and possesses the admirable advantage of providing for cleansing, without any noisome discharge. It consists of a rectangular cast-iron box, divided into two sections by a diaphragm projecting downwards from the top, a little more than half the depth of the box. The half on one side of the division has a hinged grating on the top, through which the fluid passes in, and the open space left beneath the division is the exit. After passing through this opening, the discharge rises to the same height on the opposite side of the division, and flows over the top of a second division standing up from the bottom. In this way an excellent hydraulic joint is formed in the simplest possible manner, and no effluvium can pass back from the sewer as the body of water retained in the chest hermetically seals up the egress. When in constant use, the water beneath the grid is constantly being changed, so that no smell can arise from it; and even when it stands some time, it is easily cleansed. It admits water only into the sewer, for whatever solid matter finds its way through the grid, is retained in the bottom of the chest, the water flowing off by itself. To clear away this deposit, nothing more is necessary than to raise the grid and remove it. We cannot recommend a better arrangement for avoiding the evil of noxious effluvia, as well as for preventing the passage of vermin from the sewer into the house.—Lastly, it is cheap.

THE SUB-MARINE TELEGRAPH.—The sub-marine connection between Dover on one side of the straits, and Cape Grinez on the French coast, has at length been carried out—and messages have been transmitted from side to side with the same facility as between our overland stations. The first trials have, however been terminated by the fracture of the wire close to the French side, owing, it is presumed, to the chafing action upon the rocky and irregular ground. Measures are now being taken for strengthening it by encasing it in some shielding coat, such as rope yarn, so as to give it the appearance of a six inch cable. In laying it out, the wire was wound upon a seven feet drum, placed across the deck of a steamer, right amidships. This done, and the end being attached on the Dover side, the vessel steamed out at five miles an hour, uncoiling the wire as it went, leaden weights being attached to it at intervals, as it passed over the stern. The distance across from point to point is 21 miles, but a length of about 27 miles of wire was used. Our sketch will give an idea of its formation. The copper conducting wire itself is scarcely thicker than a knitting needle, but it is encased in a thick rope of gutta percha, a material admirably suited for the purpose by its non-conducting powers, and great strength. We do not see how accidents from the dragging of anchors and fishing-nets are to be avoided—but it is proposed to lay down half-a-dozen wires, to make up for causalties of this nature.

THERMOMETRIC BALANCE FOR STOVE DAMPERS.—Mr. Appold, the inventor of the hygrometer, noticed in our pages of last month, has also contrived an elegant little mercurial apparatus for opening and closing the dampers of stoves, by the action of heat. The movement is obtained from ether, boiling in a partial vacuum, which propels the mercury from one bulb to the other. It acts with a variation of no more than one degree Fahr., and in the inventor's own arrangement, it is fixed two stories above the stove. It has the power of elevating an ounce three inches, with a variation of one degree—the range being from 54° to 66°.

ENGLISH PATENTS.

Sealed from 17th August, to 21st September, 1850.

Charles Heard Wild, St. Martin's-lane, Middlesex, civil engineer,—"Improvements in certain structures for retaining water."—August 17th.

Henry Holland, Birmingham, umbrella furniture manufacturer,—"Improvements in the manufacture of umbrellas and parasols."—22d.

Edmé Augustin Chameroy, Paris,—"Improvements in paving streets and other surfaces."—22d.

Frederick Hale Thomson, Berner's-street, Middlesex, gentleman, and Thomas Robert Mellish, Portland-street, same county, glass-cutter,—"Improvements in cutting, staining, silvering, and fixing articles of glass."—22d.

William Dick, Edinburgh, professor of veterinary medicine, Veterinary College, Edinburgh,—"Improvements in the manufacture of steel and gas."—22d.

Benjamin Roteh, Lowlands, Middlesex, Esq.,—"A factitious saltpetre, and a mode by which factitious saltpetre may be obtained for commercial purposes."—22d.

William Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in refining gold."—(Being a communication.)—22d.

William Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in the construction of ships' magazines."—(Being a communication.)—22d.

William Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in machinery or apparatus for producing ice, and for general refrigerating purposes."—(Being a communication.)—22d.

William Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in the construction of ships or vessels, and in steam boilers or generators."—(Being a communication.)—22d.

Daniel Illingworth, Bradford, Yorkshire, worsted spinner,—"Certain improvements in machinery for preparing all descriptions of wool and hair grown upon animals for the carding, combing, and other manufacturing processes."—22d.

Duncan Bruce, Paspebiac, Gaspé, Canada, but at present at Liverpool, Lancaster, Esq.,—"Certain improvements in the construction of rotary engines."—22d.

Richard Prosser, Birmingham, civil engineer,—"Improvements in supplying steam boilers with water, and in clearing out the tubes of steam boilers."—22d.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—'Improvements in cutting types and other irregular figures."—(Being a communication.)—29th.

George Augustus Huddart, Brynkir, Carnarvon, Esq.,—"Certain improvements in the manufacture of cigars, and certain improved apparatus for smoking cigars."—29th.

Sir John Scott Lillie, Companion of the most Honourable Order of the Bath, Paris, France,—"Certain improvements in the application of motive power."—September 5th.

John Saul, Manchester, cotton-spinner,—"Certain improvements in machinery or apparatus for spinning and twisting cotton and other fibrous substances."—5th.

George Smith, Manchester, engineer,—"Certain improvements in steam-engines, and also improvements in feeding or supplying the boilers of the same, part or parts of which improvements are also applicable to other similar purposes."—5th.

William Watt, Glasgow, North Britain, manufacturing chemist,—"Certain improvements applicable to inland navigation, which improvements, or parts thereof, are also applicable generally to raising, lowering, or transporting heavy bodies."—5th.

Andrew Barclay, Kilmarnock, Ayr, North Britain, engineer,—"Improvements in the smelting of iron and other ores, and in the manufacture or working of iron and other metals, and in certain rotary engines and fans, machinery, or apparatus as connected therewith."—5th.

William Erskine Cochrane, Cambridge-terrace, Regent's-park, and Henry Francis, Princes-street, Rotherhithe,—"Improvements in propelling, steering, and ballasting vessels, in the pistons of steam-engines, in fire-bars of furnaces, and in sleepers of railways."—5th.

Frederick Woodbridge, Old Gravel-lane, Middlesex, engineer,—"Improvements in machinery for manufacturing rivets, bolts, and screw blanks."—5th.

John Beattie, Liverpool, engineer,—"Certain improvements in steering vessels."—5th.

James Mather, younger, Crow Oaks, Pilkington, Lancaster, bleacher, and Thomas Edmeston, of the same place, calenderman,—"Certain improvements in machinery or apparatus for scouring, finisbing, and stretching woollen, cotton, and other woven fabrics."—5th.

Christopher Cross, Farnworth, near Bolton, Lancaster, cotton-spinner and manufacturer,—"Certain improvements in the manufacture of textile fabrics; also in the manufacture of wearing apparel and other articles from textile materials, and in the machinery or apparatus for effecting the same."—5th.

James Rennie, Gowan-bank, Falkirk, Stirling, Scotland, gentleman,—"A certain improvement or improvements in the construction of gas-retorts and furnaces, and in apparatus or machinery applicable to the same."—5th.

Pierre Erard, Paris,—"Improvement in the construction of piano-fortes."—12th.

Robert Langdon, younger, Derby, glove-manufacturer, and Thomas Parker Tabberer, Derby, aforesaid, manufacturer of elastic fabrics,—"Improvements in the manufacture of looped fabrics."—12th.

Astley Paston Price, Margate, Kent, chemist, and James Heywood Whitehead, of the Royal George Mills, Saddleworth, near Manchester,—"Improvements in filters."—12th.

Thomas Lucas Paterson, Glasgow, North Britain, manufacturer and calico-printer,—"Certain improvements in the preparation or manufacture of textile materials, and in the finishing of woven fabrics, and in the machinery or apparatus used therein."—12th.

Richard Archibald Brooman, of the firm of J. C. Robertson & Co., Fleet-street, London, patent agents,—"Improvements in purifying water, and preparing it for engineering, manufacturing, and domestic purposes."—(Communication.)—19th.

Henri Jeremy Christen, Paris, engraver,—"Improvements in cylinder printing."—19th.

Jasper Wheeler Rogers, Dublin, civil engineer,—"Certain improvements in the preparation of peat, and in the manufacture of the same into fuel and charcoal."—19th.

William Eccles, Walton-le-Dale, Lancaster, cotton-spinner,—"Certain improvements in looms for weaving."—19th.

Samuel Brisbane, Manchester, pattern maker,—"Certain improvements in looms for weaving."—19th.

James Nasmyth, Patricroft, Lancaster, engineer, and John Barton, Manchester, in the same county, copper roller manufacturer,—"Certain improvements in machinery or apparatus for printing calicoes and other surfaces; and also improvements in the manufacture of copper, or other metallic rollers, to be employed therein, and in the machinery or apparatus connected with such manufacture."—19th.

SCOTCH PATENTS.

Sealed from 22d August, to 22d September, 1850.

Thomas Lucas Paterson, Glasgow, North Britain, manufacturer and calico printer,—"Certain improvements in the preparation or manufacture of textile materials, and in the finishing of woven fabrics, and in the machinery or apparatus used therein."—22d August.

Henry Houldsworth, Coltness House, Lanark, North Britain, iron master,—"Improvements in the manufacture of iron and other metals."—28th.

James Hall, Geecross, Chester, machine maker,—"Certain improvements in looms for weaving."—28th.

Robert Westmorland Hutchinson, Camberwell, Surrey, gentleman,—"Certain improvements in saw sets, mallets, and other tools, and in apparatus or machinery for manufacturing the same."—28th.

Charles Lamport, Workington, Cumberland, ship builder,—"Certain improvements in machinery or apparatus for spinning or twisting cotton and other fibrous substances."—2d September.

Astley Paston Price, Margate, Kent, and James Haywood Whitehead, Royal George Mills, Saddleworth, near Manchester,—"Improvements in filters."—2d.

Frederick Woodbridge, Old Gravel Lane, Middlesex, engineer,—"Improvements in machinery for manufacturing rivets, bolts, and screw blanks."

Wakefield Pim, Kingston-upon-Hull, engine and boiler maker, and builder of iron steam ships,—"Certain improvements in the construction of boilers and funnels of steam engines."—4th.

William Joseph Horsfal, and Thomas James, both of the Mersey Steel and Iron Works, Toxteth Park, Liverpool, Lancaster,—"Improvements in the rolling of iron and other metals."—6th.

George Attwood, Birmingham, Warwick, copper roller manufacturer,—"A new or improved method of making tubing of copper and alloys of copper."—6th.

Thomas Priestley, Shuttleworth, Lancaster, manager, and Richard Hurst, Rochdale, in same county, cotton spinner,—"Certain improvements in machinery or apparatus to be used for preparing, spinning, and doubling cotton, wool, flax, silk, and similar fibrous materials; and also in machinery or apparatus for preparing, balling, and winding warps and yarns."—7th.

George Thompson, 12 Park-road, Regent's-park, Middlesex, gentleman,—"Certain improvements in machinery and apparatus for cutting, digging, and turning up earth, applicable to agricultural purposes."—16th.

Christopher Cross, Farnworth, Bolton, Lancaster, cotton spinner and manufacturer,—"Certain improvements in the manufacture of textile fabrics; also in the manufacture of wearing apparel, and other articles from textile materials, and in the machinery or apparatus for effecting the same."—16th.

Joseph Long, and James Long, Little Tower-street, London, mathematical instrument makers, and Richard Pattenden, Nelson-square, Surrey, engineer,—"An improvement in instruments and machinery for steering ships, which is applicable to vices, and other instruments and machinery for obtaining power."—17th.

John James Greenough, George-street, Hanover-square, Middlesex, gentleman,—"Improvements in obtaining and applying motive power."—(Communication.)—17th.

John Sidebottom, Broadbottom, Chester, manufacturer,—"Improvements in looms for weaving."—18th.

James Scott, Falkirk, Stirling, North Britain, shipwright,—"Certain Improvements in docks, slips, and apparatus connected therewith."—20th.

George Robbins, Forrest Lodge, near Hythe, Southampton, gentleman,—"Improvements in the construction of railway carriages."—20th.

IRISH PATENTS.

Sealed from 21st August, to 19th September, 1850.

George Gwynne, Sussex-square, Middlesex, engineer,—"Improvements in the manufacture of sugar."—24th August.

Robert Reid, Glasgow, Lanark, manufacturer,—"Certain improvements in weaving."—27th.

Richard Archibald Brooman, of the firm of Messrs. Robertson & Co., 166 Fleet-street, London, patent agents,—"Improvements in types, stereotype plates, and other figured surfaces for printing from."—6th September.

James Rennie, Gowan Bank, Falkirk, Stirling, North Britain, gentleman,—"A certain improvement or improvements in the construction of gas retorts and furnaces, and in apparatus or machinery applicable to the same."—10th.

Peter Fairbairn, Leeds, York, machinist, and John Hetherington, Manchester,—"Certain improvements in machinery or apparatus for preparing, spinning, and weaving cotton, flax, and other fibrous substances; also, in constructing and applying models or patterns for moulding, preparatory to casting parts of machinery employed in preparing, spinning, and manufacturing fibrous substances; and also in certain tools to be used in making such machinery."—13th.

George Thompson, Park-road, Regent's-park, Middlesex, gentleman,—"Certain improvements in machinery and apparatus for cutting, digging, or turning up earth, applicable to agricultural purposes."—14th.

George Attwood, Birmingham,—"A new or improved method of making tubing of copper, or alloys of copper."—18th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 15th August, to 18th September, 1850.

Aug. 15th,	No. 2408.	Thomas Moore, Sharp, Donegal-street, Belfast,—"Sack elevator."
16th,	2409.	Joseph Salt, Uxbridge-common,—"Pipe-socket die."
19th,	2410.	Michael Neville, Liverpool,—"Joint for fasteniug and attaching pipes."
—	2411	Thomas Busby, Baths and Washhouses, New-road,—"Valve apparatus for baths."
—	2412.	Henry Fletcher, Manchester,—"Drawing roller."
—	2413.	Thomas Brookes, Spital-square, Norton Folgate,—"The Sutherland silk."
20th,	2414.	Lewis Lee, Woodbury, near Exeter,—"Cultivating plough."
22d,	No. 2415.	Schofield, Brown, Davis, and Halse, Gresham-street, London,—"The University cravat."
23d,	2416.	J. Swain and Co., Oxford-street,—"The Syrian paletot."
—	2417.	J. Swain and Co., Oxford-street,—"The Syrian jacket."
24th,	2418.	Samuel Rooke, Jun., Whitehall-street, Birmingham,—"Oxonian ink-pot."
—	2419.	Bernhard Samuelson, Banbury, Oxford.—"Beater to be used in making butter."
27th,	2420.	William G. Armstrong, Elswick Engine Works, Newcastle,—"Hydraulic equalizer."
31st,	2421.	William Elliot Carrett, Leeds,—"Steam pump."
—	2422.	William Bird, Oxford-street,—"Boot."
—	2423.	Michael Macmanus, Blackburn, Lancashire,—"Parexograph, or self-acting cooving guide to assist in copying writing."
—	2424.	David Hodge and Thomas Roberts, Hatton Garden,—"Candle lamp."
Sept. 3d,	2425.	John Tanner, Bristol,—"Trousers."
—	2426.	William Newman and William Newman, Jun., Wolverhampton and Birmingham,—"Imperial door spring."
—	2427.	Alfred Moring, Artillery-place, West Bunhill-row,—"Nepaulese braces."
—	2428.	L. D. Smith, Little Knight Rider-street,—"Colouring embossing apparatus."
6th,	2429.	Hugh Booth, Swinton, Lancashire,—"Fork for the weft stop motion used in looms, or machinery for manufacturing woven fabrics."
7th,	2430.	William Craig and Isaac Whitesmith, Glasgow,—"Brake for slubbing and roving frames."
9th,	2431.	Lewis Cooke Hertslet, Fitzroy-park, Highgate,—"Double socket-joint for connecting tubes, or pipes without flanches."
—	2432.	Leman Zox, Long-acre,—"Cape, or cloak, with hood for travelling or walking."
—	2433.	James Isaacs Sands, and Henry Edward Outtram, Holborn-hill —"Self-supporting trousers."
10th,	2434.	George Wolstenholm, Sheffield,—"Doubly carbonised I. X. L. razor."
12th,	2435.	Thomas Honnor, Leadenhall-street,—"The 'Utilis' over-coat."
—	2436.	Henry Phillips, Birmingham,—"Shield for brooch pins."
13th,	2437.	Enoch O. Tindall and Lorenzo Tindall, Scarborough.—"Cooking range."
16th,	2438.	H. J. & D. Nicoll, Regent-street,—"Wrapper cloak."
—	2439.	C. R. Mead, Old Kent-road,—"Gas meter."
17th,	2440.	Edward Bing, Ramsgate,—"Window and door weather joint."
—	2441.	Thomas Boyle, Wolverhampton,—"Trousers strap."
18th,	2442.	Joseph Welch and John Margetson, Cheapside,—"Cantah braces.

TO READERS AND CORRESPONDENTS.

In our notes of "the British Association in Edinburgh," last month, we find we have fallen into a slight error in one little point, which may as well be corrected here. We stated that the yacht which conveyed our party to the Bass Rock was the property of Sir Charles Malcolm, instead of Mr. G. H. Girle, who is the real owner.

"On Calculating Change-Wheels for Screw Cutting."—In this article, page 111, for August, 14th line from top, for "$\frac{1}{64}$ of an inch," *read* "64 threads per inch."

J. G. O., Manchester.—We do not place much reliance on the authority he quotes. We have not space this month to render him sufficient assistance. If he will wait until November, we may do something for him.

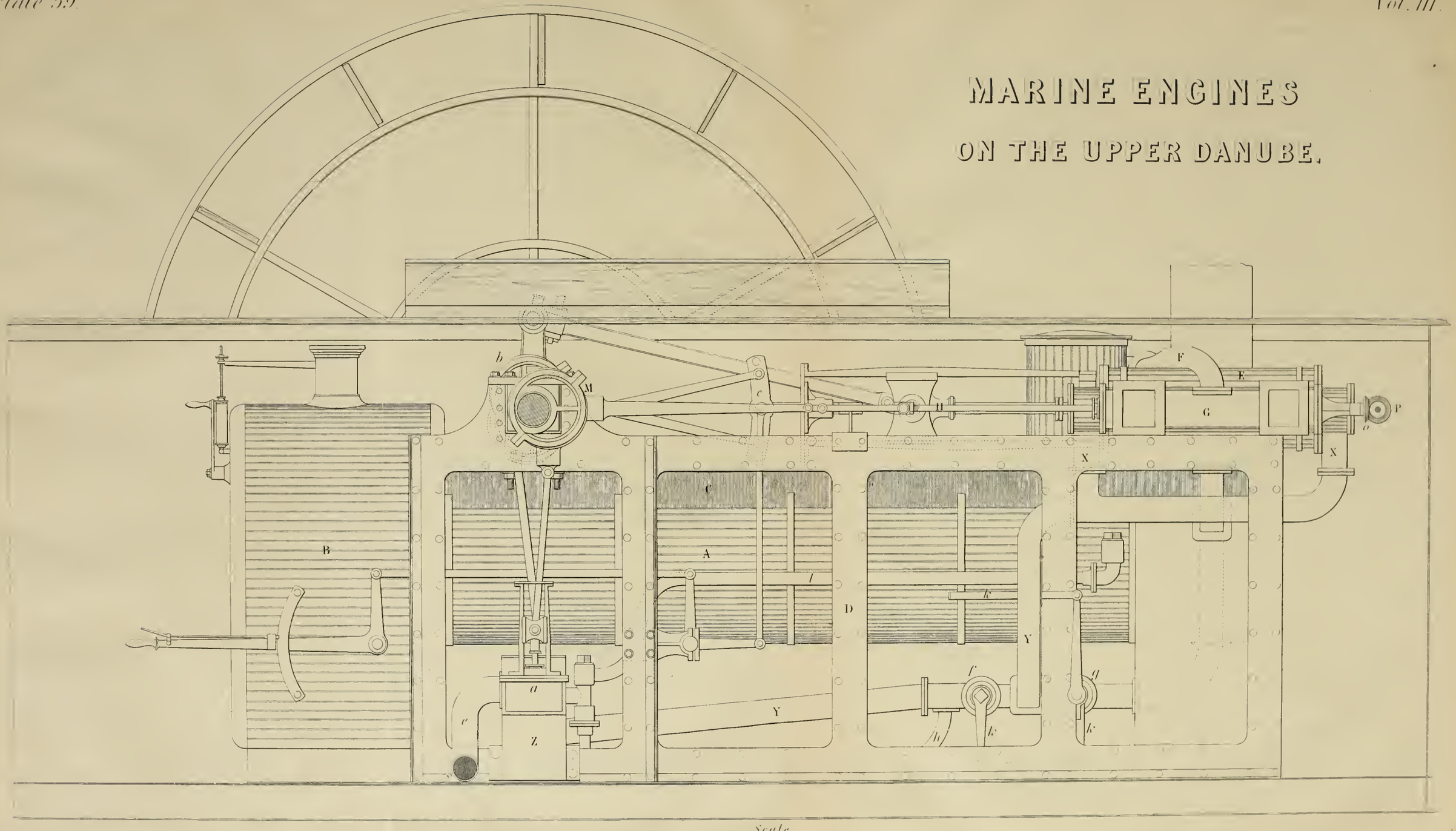
J. S.—We are obliged by his polite favour. Any contributions of the kind he mentions will be most acceptable.

Messrs. W.—We have received the specimens of production, which are very good. In November we shall be able to say something on the subject, as we shall then have seen the machine.

P. M.—Too late for the present number. We shall bear in mind his other remarks.

A. F. W.—Pebbles are what is vulgarly termed "cooler" than common glass. If he exposes the two kinds of glasses to vapour, he will see that the real pebble condenses it much more effectively than the glass. The file is also a test. Pebbles can scarcely be touched with the file. They are made from natural rock crystal.

MARINE ENGINES
ON THE UPPER DANUBE.



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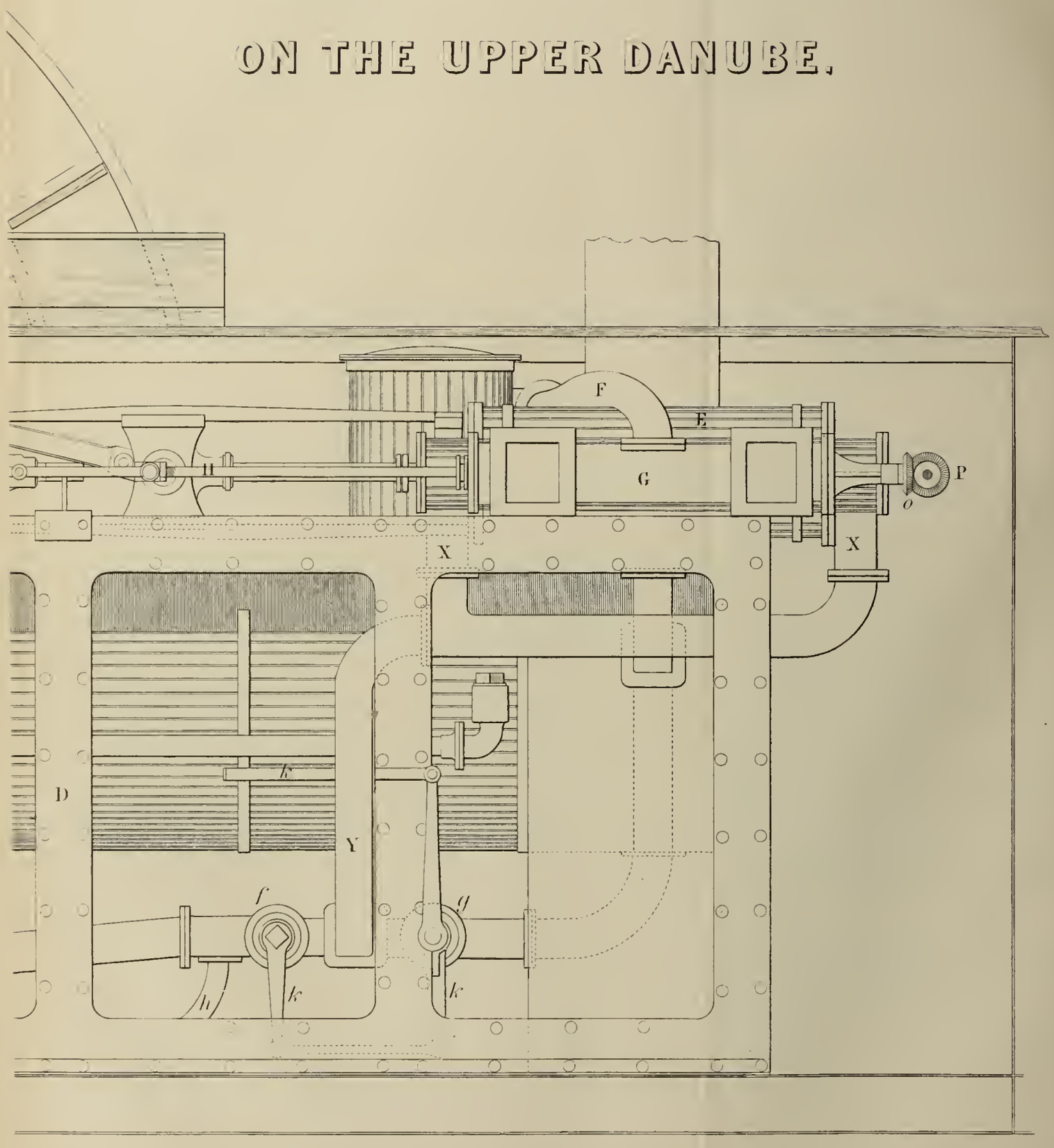
Vol. III.

MARINE ENGINES

ON THE UPPER DANUBE.



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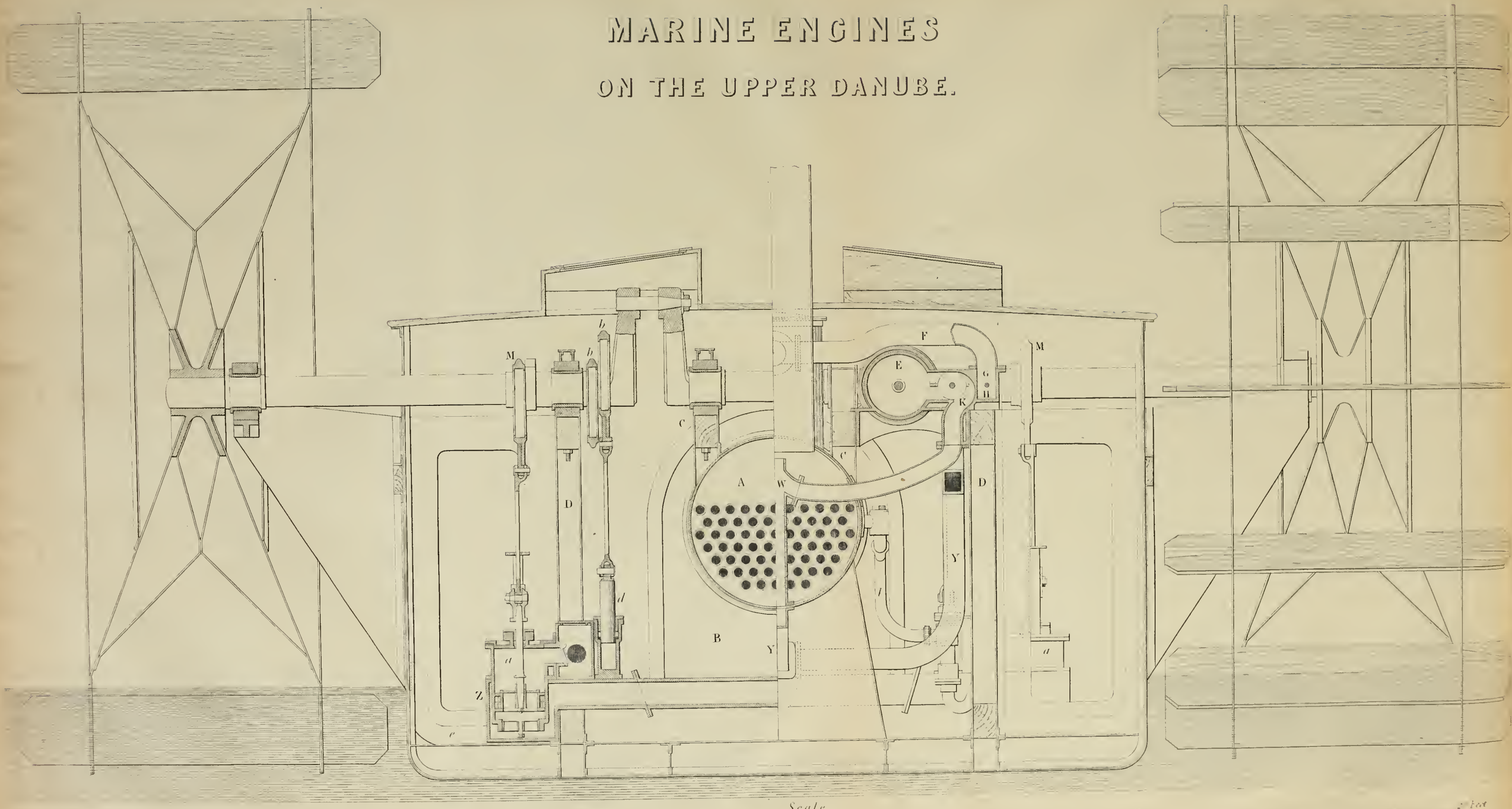
Engd by Geo. Aikman, Edinr.

MARINE ENGINES

ON THE UPPER DANUBE.



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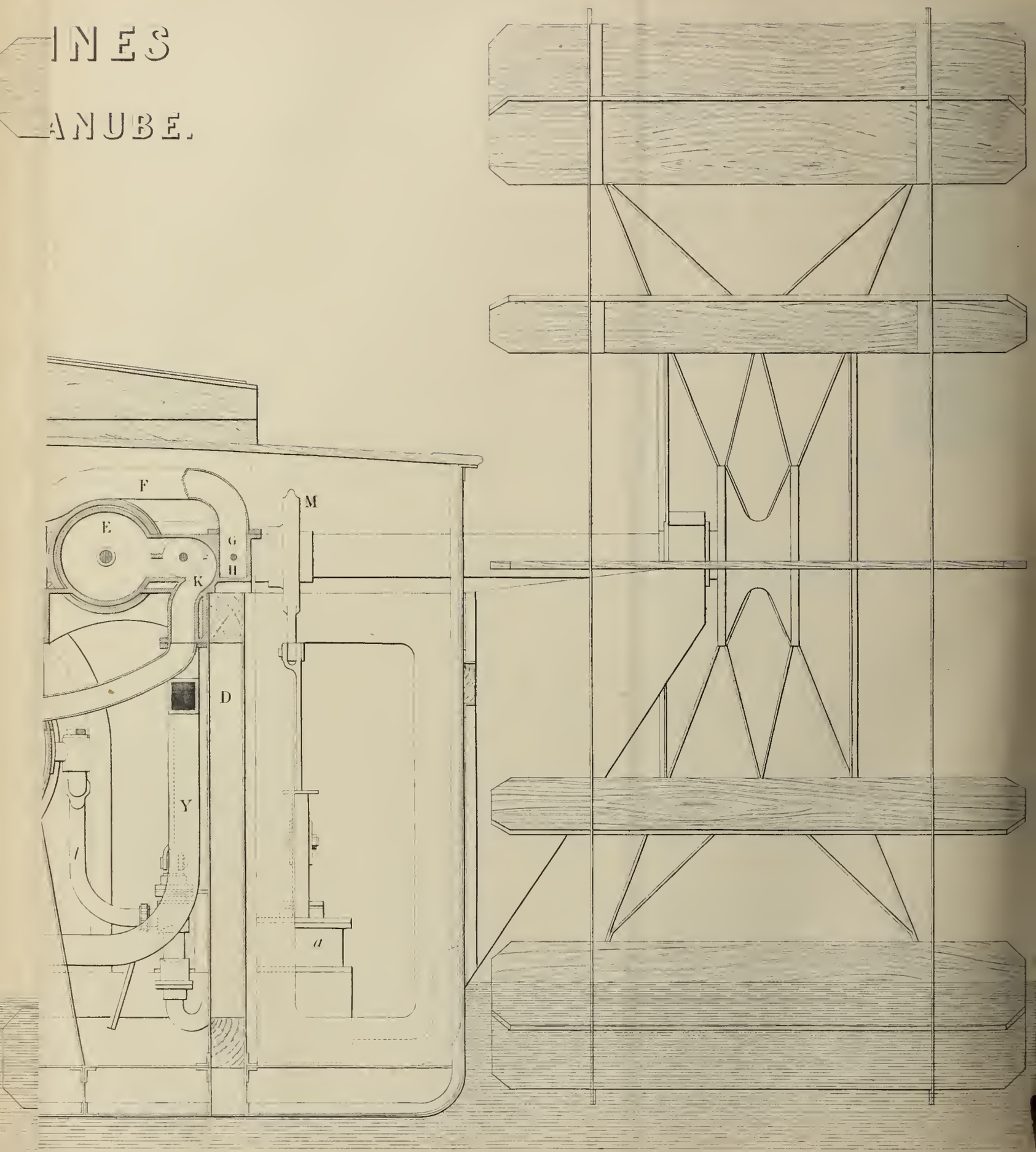
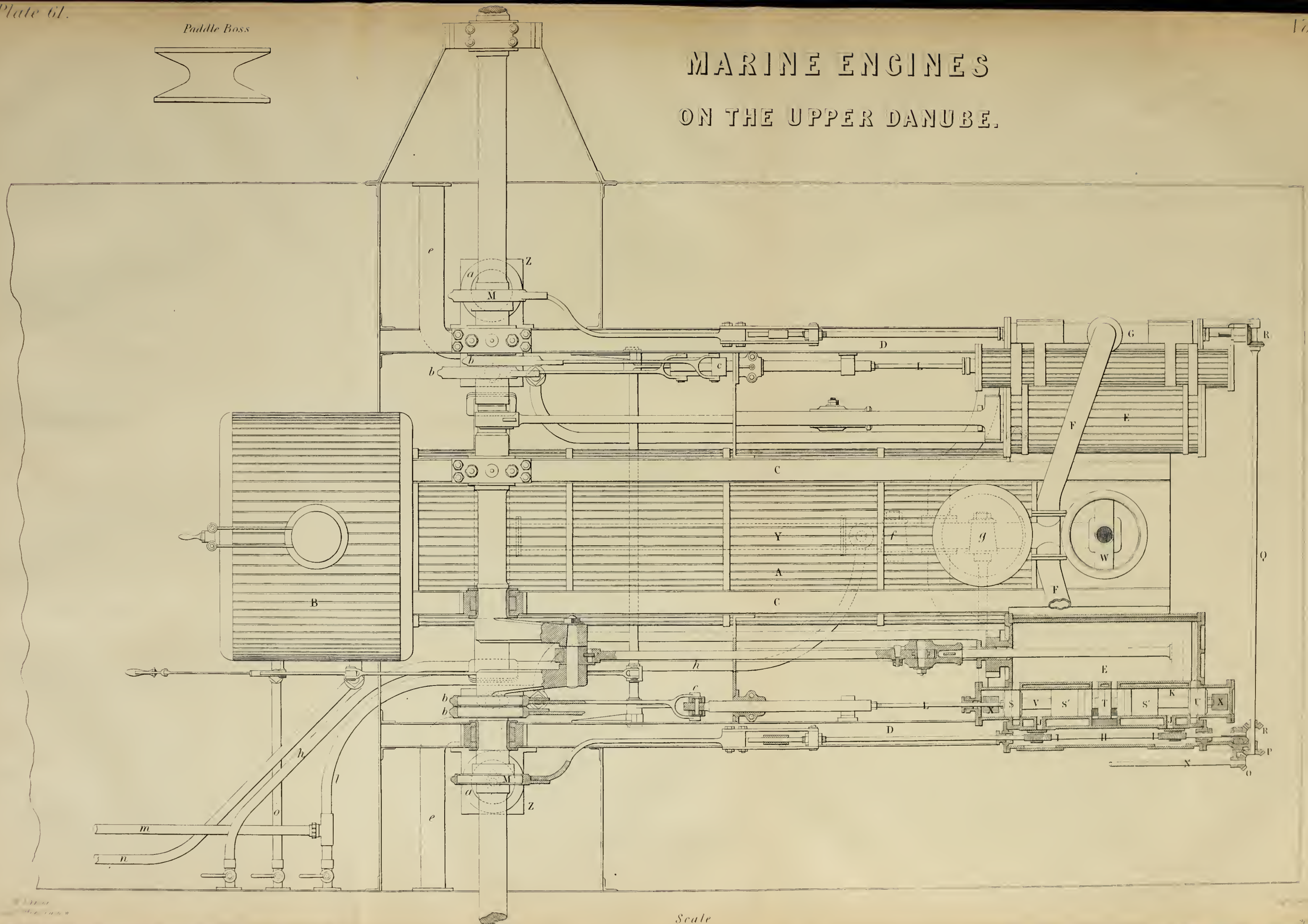


Engd by Geo Gorman 2 Coll.

Paddle Boss

MARINE ENGINES

ON THE UPPER DANUBE.



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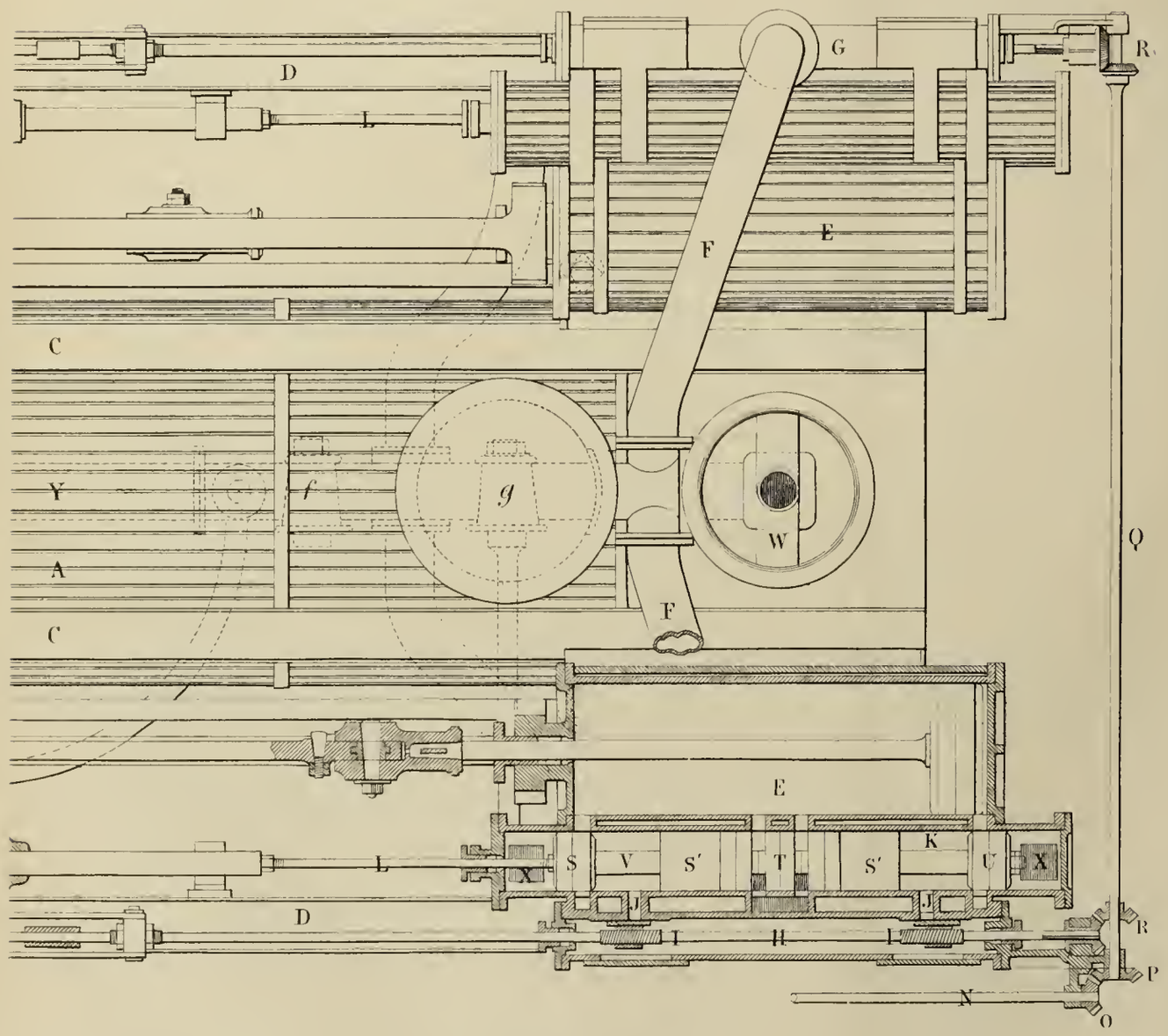
E UPPER DANUBE.



Engd by Geo. Aikman Edin.r

15

20 Feet

MARINE ENGINES ON THE UPPER DANUBE.

(Illustrated by Plates 59, 60, and 61.)

The readers of our first volume will remember the appearance, in our early numbers,* of two plates of a pair of "oscillating mariue engines, with link valve motion," designed by Mr. Joseph Hall of Munich, and fitted in a boat on the Upper Danube. We now present a set of three plates, illustrative of another arrangement, by the same designer, at present at work in a steamer plying on the same river.

As the superintendent of M. Von Maffei's extensive engine works at Hirschau, near Munich, Mr. Hall has had several years' practice in building and fitting out steamers for the shallow and rapid Danube, and the present design will show what he has accomplished against the difficulties of lack of water and rapidity of current. In the hot season, the river has not above 18 inches of water in many places—so that, on the one hand, the draught of the boat is inordinately restricted, whilst it is absolutely necessary to use very powerful engines to overcome the current in running up the stream. The engines must, therefore, be large in comparison with the size of the vessel, seeing that a rate of ten miles per hour is to he maintained in the up trip.

In 1848, when the Bavarian government ordered another steamer for this navigation, Mr. Hall, after some consideration of the contradictory exigencies of the case, conceived the idea of constructing a high-pressure engine, on the principle of the ordinary locomotive, so as to economise space, stowage, and weight, as much as possible. As this idea met with the approval of M. Exter, one of the superintending government engineers, the boat was fitted out according to the new plan towards the end of the season of 1848, and has since been in regular employment up to the present date. She runs between Regensburg, Ratisbon, and Linz, and has answered sufficiently well to induce the government to order three more boats of similar construction, but still smaller, to suit the shallower water between Regensburg and Ulm.

During the fitting-out of the new steamer, Mr. Hall, whilst partly regretting the superseding of the old condensing engine, began to consider the advantages likely to arise from the combination of the high-pressure and condensing systems in one. His first idea was to make use of the waste steam to cause a blast for a steam generator through the blast-pipe; and, second, to condense the waste steam which the atmosphere prevented from escaping. The original design was made in Juue, 1848, and was carried out in M. Maffei's establishment, under the auspices of M. Exter, and with the able professional assistance of Mr. Ashton, the English engineer of the works. The arrangement is very fully detailed in our three plates. Plate 59 is a complete side elevation of one of the engines, with boiler and paddle-wheel, as fitted in the vessel. Plate 60 is a corresponding transverse section through the vessel, showing both engines, with various parts in section. The view on the left of the centre line represents sections through the paddle-box, air-pump, feed-pump, crank shaft journals, condenser passage, and the barrel of the boiler—the cylinders not being shown. On the right, the air-pump and paddle-wheel are in elevation, the cylinder being in section through its exhaust passage, as in connection with the blast-pipe. Plate 61 is a plan of the combined engines, one being in horizontal section.† The boiler and fire-box, A B, are constructed just as in a locomotive. At C C, are two parallel frames of double-boiler plate, filled in with timber, running along the boiler, and riveted fast to it. D D, Are two similar frames, standing up from the bottom of the boat; and these four lines of framing carry, at one end, the four inner journals of the paddle-shaft, and, at the other, the pair of steam cylinders, E E. The steam is admitted in the usual way by a regulator in the dome through the pipe, F, to the steam-chest, G. The slide-valves are made on the ingenious principle introduced several years ago by Mr. Bodmer of Manchester. The expansion-valve spindle, H, has a right and left hand screw at I I, each screw having a plain cut-off slide, commanding the steam ports, J, leading into the second steam-chest, K, and fitted with piston-valves worked by the spindle, L. The cut-off spindle, H, is worked by the outside eccentric, M, the rod of which is linked to it direct. The variation in the expansion is effected by the light shaft, N, passing alongside the engines to the engineer's hand, and having a bevel pinion, O, gearing with a similar pinion, P, on the transverse shaft, Q, passing across between both engines. In this way the shaft, N, commands the valves of both engines through the two pairs of bevel pinions, R R—the result of turning the shaft, N, to the right or left being to expand or approximate the two cut-off slides by the right and left screws, and thus increase or diminish the degree of expansion without affecting the lead. The cylindrical, or piston-valve chest, has three valves, S T and U, on the same rod, V; and, as represented in the horizontal section, plate 61, the engine is upon its bottom centre, and steam is entering between the valves, U and T; the valve, U, being on the point of opening to admit steam to the cylinder—the waste steam of the previous stroke having escaped by the opening cast in the middle of the cylinder, and through similar recesses formed in the valve, T, into the blast-pipe, W. Now it is to be remembered that the valve, U, must travel downwards until its port leading into the cylinder is full open; and, as the whole three valves are on one rod, as U is opening to admit steam to the cylinder, T is closing the commuuication between the cylinder and the blast-pipe. So soon as the ports to the blast-pipe—which are only half the width of the valve—are closed, the other valve, S, opens, and the remaining vapour escapes through the pipes, X, cast on the steam-chest, to the pipe, Y, leading to the condenser, Z. As the expansion at each stroke commences at the face of the cut-off slides, whatever amount of steam may be in the piston-valve chest at the time is also expanded; therefore, to diminish this amount as much as possible, two additional pistons, s′ s′, are fitted upon the valve-rod, for the purpose of displacing the steam which would otherwise collect at each stroke in the valve-chest. The air-pump, *a*, is of the ordinary construction: it is bolted on to the condenser, and is worked by the same eccentric which works the expansion valves. The piston steam-slides, S T and U, are worked by the back and forward eccentrics, *b b*, through the reversing link, *c*. The backward eccentric also works the feed-pump, *d*—the feed being taken from the hot well, whilst the remainder runs to waste by the pipe, *e*.

The steam is admitted to the cylinder when the piston is on the centre, and is allowed to escape to the eduction-port or blast-pipe when the piston is $1\frac{3}{4}$ths iuch from the end of its stroke. The valve, S, opens to the condenser when the piston has travelled $1\frac{3}{4}$ths inch from the commencemeut of its stroke—the full length of stroke being 30 inches—so that the cylinder is open to the condenser when the piston has travelled $\frac{1}{17}$th of its stroke.

At *f* and *g*, two cocks are placed upon the pipe, Y, leading to the condenser, and these cocks are so arranged that when one is open, the other is shut. The injection-pipe, *h*, is placed between the air-pump and the cocks, *f* and *g*, so that by reversing the latter by means of the rods and levers, *k*, *k*, the engine will work with the condenser or without it. When working without the condenser, the cylinder is open to the atmosphere throughout the entire stroke, as in the common high-pressure engine, and under such circumstances the pipe, *l*, is open to the feed-pump for the boiler supply. The pipe, *m*, leads to a small steam pump not seen in the drawing, and the pipe, *n*, conveys the water from the steam pump to the boiler. The pipe, *o*, is the blow-off pipe.

As this plan presents many novelties, it was Mr. Hall's intention to have delayed making it known until further experience with it had shown how far it might be improved upon, but the appearance of Mr. Siemen's paper* in connection with a scheme of a similar nature has induced him to submit it to us at once. That the two inventions were

* Pages 58 and 80, vol. I.

† This plate, the same size as the two preceding ones, will be given next month.

* *Practical Mechanic's Journal*, page 91, for July.

entirely distinct, scarcely admits of doubt; but the fact of a steamer on Mr. Hall's plan being at work at the early date we have mentioned, sets at rest the question of priority.

The more extended adoption of the new arrangement by the Bavarian government will afford good opportunities for testing different modifications of the system, and we may probably, hereafter, be in a position to state the behaviour of the three new vessels now being fitted out.

THE PHILOSOPHY OF MATHEMATICAL SCIENCE.

No. II.

In order to close our general exposition of the fundamental division of mathematical science, it only remains that we define, as precisely as can be done in this place, each of its two grand sections.

Concrete mathematics having for their object the discovery of the equations of phenomena, would seem, *a priori*, to be composed of as many distinct sciences as there are different classes of natural phenomena. But much is wanting before we attain to a discovery of mathematical laws in all classes of phenomena—nay, we shall presently see that the greater part of them will always elude our efforts. In reality, in the present condition of the human mind there are only two grand general categories, the equation whereof we have attained to a knowledge of; and these are, geometrical phenomena and mechanical phenomena. The concrete part of mathematics is therefore composed of geometry and theoretical mechanics.

This is sufficient, it is true, to give the science a complete character of logical universality, when the whole of the phenomena are looked at from the most elevated point of view in natural physics. If every part of the universe was conceived as being without motion, it is evident that we should only have to deal with geometrical phenomena, since everything would be reduced to relations of form, magnitude, and position; but, having regard to their motions, we have also to consider mechanical phenomena. It may therefore be laid down that, viewed with reference to statics, the universe only presents geometrical phenomena; and with reference to dynamics, only mechanical phenomena. Thus, geometry and mechanics constitute of themselves the two natural fundamental sciences, in the sense that all the phenomena of nature can be conceived as necessarily resulting either from the laws of space, or from the laws of motion.

But though it is always logically possible for us to consider the matter in this light, we are met by great difficulties when we come to apply the conceptions here involved, to special facts, with the precision the case requires; and to pursue them with accuracy through each of those general cases which the study of nature brings into view—in other words, when we come to convert the chief problems of natural philosophy, in any given class of phenomena, into those problems of geometry or mechanics, out of which the former are supposed to arise. This conversion, which requires, as a preliminary, great progress in the study of each class of phenomena, has not really been made up to the present time, except with regard to astronomical phenomena, and a part of those considered by terrestrial physics. In this way, astronomy, acoustics, optics, &c., have at length become applications of mathematical science to certain kinds of observations.* But these applications not being by their nature rigorously defined, to confound them with mathematical science, as is done in the ordinary division of mathematics into pure and applied, would be to assign to that science a vague and indefinite domain. We shall therefore continue to regard concrete mathematics as composed of geometry and mechanics only.

As to *abstract* mathematics, its nature is clearly and accurately determined. It is composed of what is termed the calculus, taking the word in its most extensive signification, which embraces the simplest numerical computations, as well as the grandest combinations of transcendental analysis. Its peculiar object is to resolve all problems involving numbers. Its starting point is constantly and necessarily the knowledge of precise relations; that is to say, equations between the different magnitudes which are simultaneously under consideration, this being on the other hand the terminating limit of concrete mathematics. However complicated or indirect these relations may be in other respects, the end and aim of the science of calculus are always to deduce from them the values of unknown quantities by means of those of known quantities. This science, although carried to greater perfection than any other, is, in very fact, but little advanced as yet, so that its aim is rarely attained in a completely satisfactory manner. Such, however, is its true character. To obtain a clear conception of the real nature of any science, we must always consider it as having attained to its perfect state.

In order to sum up in the most philosophical manner possible the views hereinbefore expounded as to the fundamental division of mathematics, it is important to remark, that the division in question is nothing more than an application of the general principle of classification which the true hierarchy of the various positive sciences has enabled us previously to establish. If, then, we compare on the one hand the calculus, and on the other geometry and mechanics, we shall discover, relatively to the notions considered in each of these two principal sections of mathematics, all the essential characters of our encyclopedic arrangement. The ideas of analytical mathematics are at once more abstract, more general, and more simple, than those of geometry or mechanics. Although the principal conceptions of mathematical analysis derive their origin, historically considered, from geometry or mechanics—with the perfection of which sciences the progress of the calculus is closely allied—analysis is not, under a logical point of view, the less essentially independent of those sciences, whilst they on the other hand are based upon it.

Mathematical analysis is therefore to be considered the true rational basis of the entire system of our positive knowledge. It constitutes the first and the most perfect of all the fundamental sciences. The ideas with which it deals are the most universal, abstract and simple, that it is possible for us to conceive. We cannot attempt to go further without getting involved in metaphysical reveries. For what real *substratum* of practical use for our reason to deal with will remain, if we go on to suppress any circumstance in the notions of indeterminate quantities, constant or variable, such as geometers employ at present, with the hope of reaching some imaginary higher degree of abstraction, as the ontologists believe?

The peculiar nature of mathematical analysis affords an easy explanation why it offers such powerful means, not only for giving more precision to our actual knowledge (this is self-evident), but for establishing a coordination infinitely more perfect in the study of the phenomena which allow of that application. For the conceptions having been generalised and simplified to the utmost, so that a single analytical question, abstractly resolved, contains the implicit solution of a number of different physical problems, there must necessarily result a greater facility for the mind's perceiving relations between phenomena which at first appear entirely isolated, and from which we have succeeded in extracting that which they all have in common, in order to consider it by itself. Hence, in advancing from the solution of one important problem in geometry and mechanics to another, we discover approximations the most unexpected, in problems which originally offered no point of similarity whatever, and we frequently end in finding that they are identical. For instance, without the help of analysis, would it have been possible for us to perceive the least analogy between the determination of the direction of a curve at each of its points, and that of the velocity acquired by a body at each instant of its variable motion? questions which, however different in their expression, only compose one in the eyes of the geometer.

The high perfection which mathematical analysis has attained, in comparison with other branches of positive knowledge, will be readily understood when its general character has been truly seized. This result is not owing, as some metaphysicians, especially Condillac, believed, to the concise and general signs employed as the instruments of reasoning. In this respect the influence of those signs has been greatly exaggerated, though doubtless it has been considerable. The greater part of geometers known, had expressed as much as this before Condillac wrote, and in a much more accurate manner. In reality, algebraical signs contributed no essential assistance in obtaining any of the grand ideas of the analysis, further than aiding to grapple with and work out those ideas after they had been obtained. The superior perfection of abstract mathematics is principally due to the extreme simplicity of the ideas with which they deal, express them by what signs you will; so that there is not the least hope that by means of any artifice of scientific language whatsoever (supposing such possible), we shall be able to carry to the same degree of perfection those theories which, bearing upon more complex notions, are by their nature necessarily condemned to a logical inferiority, more or less great, according to the corresponding class of phenomena.

The examination we have undertaken of the philosophical character of mathematical science would be incomplete, if, having noticed its object and its structure, we refrained from indicating some general considerations touching the actual extent of its domain. It is indispensable to our obtaining a just idea of the true nature of mathematics, that we recognise in the first place its necessary and rigorous universality, when contemplated under a purely logical point of view. Since there is no question whatever which cannot be conceived as consisting ultimately

* The mathematical theory of the phenomena of heat has assumed such an aspect in the hands of Fourier, that we may now consider it, after geometry and mechanics, as a third and distinct section of concrete mathematics: he having established thermological equations in a manner entirely direct, instead of hypothetically representing the problems as application of mechanics; in the manner attempted, for instance, with regard to electrical phenomena. This great discovery, which, like all those connected with a true method, has not yet been properly appreciated, singularly merits our attention—for besides its immediate importance in the rational and positive study of an order of phenomena so universal and fundamental, it tends to raise our hopes as to the future extension of the legitimate applications of mathematical analysis.

in determining some quantities by others according to certain relations, and which, consequently, cannot in the end be reduced to a simple question of numbers. This we shall comprehend if we observe that, in all our enquiries, no matter with what order of phenomena they are concerned, we have in view to arrive ultimately at numbers, at quantities. Although we seldom reach these, except in a rough way, and by very uncertain methods, it is not the less evident that such is the real termination of all problems whatsoever. Thus, to draw an example from a class of phenomena least accessible to the mathematician, the phenomena of living bodies—contemplated, let us suppose, for greater complication, with reference to disease—is it not manifest that all the questions of therapeutics may be looked at as consisting in determining the quantities of the different things capable of modifying the frame so as to restore it to its normal state, by introducing, according to the practice of geometers, negative values or zero, or even contradictory values, in place of some of those quantities in certain cases? Doubtless such a mode of representing the problem cannot, as we shall see, be actually pursued in practice, in the most complex phenomena, because insurmountable difficulties attend its application; but when the abstract conception of the whole bearing of a science is the question, we are bound to attribute to it the total extension of which it is logically susceptible.

An objection to such a conception may be drawn from Kant's categorical division of human ideas into quantity and quality, the first alone constituting the exclusive domain of mathematical science. But the development of this science has long ago completely disproved the reality of this superficial metaphysical distinction. For the fundamental position of Descartes, as to the relation of the concrete to the abstract in mathematics, proves that all ideas of quality are reducible to ideas of quantity. This position, at first announced by its immortal author with reference to geometrical phenomena only, was afterwards extended by his successors to mechanical science, and in our day it has been extended to the phenomena of heat. The result of this gradual generalisation is, that there are now no mathematicians who do not believe that it may be applied, in a purely theoretical sense, to all our ideas drawn from external things; so that every phenomenon might be represented by an *equation*, as well as a curve or a motion, if we could only surmount the difficulties of discovering the equation and of resolving it: such difficulties, however, being at present, in very many cases, superior to the greatest efforts of the human mind.

But if, in order to form an adequate idea of mathematical science, it is important to consider it as being necessarily possessed of a rigorous logical universality, it is not the less indispensable to consider, in the next place, the great limitations which, by reason of the weakness of the human mind, so considerably narrow its effective domain in proportion as phenomena become complicated with details. Every question, beyond doubt, can, as we have just seen, be conceived as reducible to a pure question of numbers. But the difficulty of dealing with it in point of fact, under this aspect, that is to say, of effecting such a transformation, is so much the greater in the various essential parts of natural philosophy, as the phenomena under consideration are more complex, so that, except the simplest and the most general phenomena, it frequently becomes quite insurmountable.

This will be immediately seen, if we consider that, for a question to fall within the domain of mathematical analysis, it is first necessary to discover the precise relations between the several quantities coexistent in the phenomenon before us, the establishment of these equations being the necessary starting-point for all analytical labours. Now this must evidently be difficult in proportion to the speciality, and consequently to the complication, of phenomena. Examining, under this point of view, the different fundamental categories of natural phenomena previously established, we shall find, after a close consideration, that it is only in the three first at most (comprehending all *inorganic physics*), that we can fairly hope to reach, at some future time, to that high degree of scientific perfection. A general exposition of this position must here suffice.

In order that phenomena should admit of the application of mathematical laws, the first condition evidently is, that the different quantities they present should afford ground for fixed numbers. Now, on examining the two principal sections of natural science, we see that the whole of *organic* physics, and probably also the more complex parts of *inorganic* physics, are, by their very nature, necessarily unapproachable by mathematical analysis, on account of the extreme numerical variability of the respective phenomena. Every precise idea of fixed numbers is quite out of the question in the phenomena of living bodies, if we would attach any importance to the exact relation of the assigned values, or would employ them otherwise than as a means of directing the attention.

The several properties of inorganic bodies, especially the most general, present a high degree of fixity; at most they only experience changes of a simple nature, separated by long intervals of uniformity, and it is, therefore, possible to bring them under precise and regular laws. Thus the physical qualities of an inorganic body, especially when it is a solid—its form, consistence, specific gravity, elasticity, &c.—present, for a considerable time, a remarkable numerical constancy, which allows us to consider them under a mathematical point of view. This is much less the case in the chemical phenomena of the same bodies. These being more complex, and dependent upon a much larger number of circumstances, present greater and more frequent, consequently more irregular, variations. It must, therefore, be assumed that fixed numbers cannot at present be associated with chemical phenomena, even under the simplest relation—the relative proportions of bodies in combinations—and this clearly demonstrates how far such an order of phenomena is from yielding mathematical laws. Not to wander into a too minute discussion of the general limits of the actual domain of mathematical analysis, let us, notwithstanding what we have just said, admit, for this occasion, its possibility, and even its future probability. There will not be the least doubt about it as soon as we shall pass to the phenomena presented by bodies considered in that state of continual intestine agitation of their particles which essentially constitutes what is termed *life*, looked at from the most general point of view in the whole of the beings which manifest it. In fact, a character eminently peculiar to physiological phenomena, rendered more sensible from day to day by their more accurate investigation, is the extreme numerical instability which they present under whatever aspect they are examined, and which necessarily follows from the very definition of living bodies. All the facts establish this position: That every property of an organised body, geometrical, mechanical, chemical, or vital, is subjected, in its amount, to immense numerical variations, altogether irregular, which succeed each other at close intervals, under the influence of a multitude of circumstances, external as well as internal; those very circumstances being also variable—so that all hope of fixed numbers, and consequently of mathematical laws, is directly contradicted by the special nature of this class of phenomena. Therefore, when we wish to value with precision even the simplest properties of a living being—for instance, its mean density, or the density of one of its principal constituents, its temperature, the velocity of its interior circulation, the proportion of the elements constituting its solids or fluids, the quantity of oxygen consumed in a given time, the amount of its absorptions or exhalations, &c., and, *a fortiori*, the energy of its muscular forces, &c.—to obtain each of these results there must not only be made as many observations as there are species of phenomena, or varieties of species, but we must also measure the changes which that quantity experiences in different individuals; and, with respect to the same individual, according to its age, state of health, and those ever fluctuating circumstances (atmospheric, &c.) to the influences of which it is subjected. What then can be intended by those pretended numerical values so carefully registered for the different physiological or even pathological phenomena, taken, in the most favourable case, from one single natural standard, when a multitude are required? All they do is to conceal the real interpretation of phenomena; they cannot be rationally employed except, so to speak, as a mnemonical aid, to fix our conceptions. In all such cases, it is evidently totally impossible ever to obtain true mathematical laws. And as to social phenomena, which involve a still greater complexity, and, consequently, greater variations, this is still more palpably the case.

Nevertheless, we are not to abandon the idea that, in philosophical contemplation, phenomena of every kind are really and necessarily under the rule of mathematical laws: we are to consider that it is only the complication of phenomena which prevents us ascertaining them, in the majority of instances. For if it was possible rigorously to isolate each of the simple causes which combine in the production of a physiological phenomenon, everything leads us to believe that it would be found to possess, under the given circumstances, an influence and action as exactly fixed as we find in the case of gravitation. What produces the irregularities is the great number of different agents simultaneously engaged in the production of a phenomenon, and hence, in phenomena of great complexity, there are, perhaps, not two cases exactly alike. There is no need that we should betake ourselves to the phenomena of living bodies for a difficulty of this kind; inorganic bodies of the more complex class—for instance, meteorological phenomena—present examples of it. We cannot doubt that each of the numerous agents which concur in producing these phenomena is really subjected to mathematical laws, although we are yet unacquainted with the greater part of them; but their number renders the observed effects as irregularly variable as if the causes were none of them subjected to any precise condition.

And this leads us to perceive another reason why we are prevented, as a consequence of the feebleness of our faculties, from bringing the study of the more complicated phenomena within the domain of mathematical analysis. Independently of the results of the most special phe-

nomena being so variable that we are unable to seize their fixed values, their complication gives rise to this difficulty, that, even if we were to arrive one day at a knowledge of the mathematical law governing each separate agent, yet the combination of so great a number of conditions would render the corresponding mathematical problem so intricate as to place the question, in the majority of cases, beyond the comparatively feeble means we possess for solving it. Hence, we must not look for any fruitful result from this mode of studying natural phenomena.

In order to perceive the full amount of this difficulty, let us consider how far mathematical questions become complicated, even in connection with the simplest phenomena of inorganic bodies, when we would advance from the concrete to the abstract, and take into account all the principal conditions which exercise a real influence on the result. For instance, we know that the very simple phenomenon of the motion of a fluid, under the influence of gravity alone, through a given orifice, has not, to the present time, received a complete mathematical solution, when all the essential circumstances are taken into account. And the same remark must be made with reference to the still simpler motion of a projectile in a resisting medium.

How is it, then, that mathematical analysis has been so successful when applied to celestial phenomena? The reason is, that those phenomena are, in spite of appearances, much more simple than any other. The most complex problem which they offer, that of the modification, produced in the motion of the two bodies tending towards each other by virtue of their mutual attraction, by the influence of a third body acting in like manner on the other two, is in reality much less complex than the simplest terrestrial problem. And yet it contains so much difficulty that we have only as yet attained to an approximate solution. Moreover, when we examine the matter more deeply, we cannot help but see that the high perfection to which solar astronomy has been raised, with the assistance of mathematical science, is owing in a great measure to our skilful use of various, and, so to speak, accidental facilities which the peculiar constitution of our solar system has afforded us in solving the problems. The planets which compose that system are not very numerous; then they have very unequal masses, are much less than the sun, and are placed at great distances from each other; their orbits are nearly circular, and have very small mutual inclinations, &c. Hence the perturbations are seldom very considerable, and it is ordinarily sufficient for their calculation only to take into account, in addition to the action of the sun on any given planet, the influence of a single other planet, capable by its magnitude and proximity of occasioning sensible derangements. But if in place of such a state of things our system had been composed of planets concentred within a small space, and of nearly the same size; if their orbits had been very differently inclined, and the eccentricities considerable, if these bodies had been of a more complex form, for instance, highly eccentric ellipsoids, &c., it is certain that we should not have succeeded in bringing the celestial phenomena within the range of our mathematical analysis, and probably we should not have been able even to enucleate the principal law.

These hypothetical conditions would be found exactly realised in chemical phenomena, if we were to undertake their calculation in the same manner as the theory of gravitation.

After duly weighing these considerations, I think we shall be convinced that in limiting the future extension of mathematical analysis to inorganic physics, I have rather exaggerated than cut down the extent of its effective application. If it was of moment to bring into view the rigorously logical universality of mathematical science, it was just as important to mark out the limits of its practical application, in order not to tempt the mind from the right path in search of a chimerical perfection, when studying complicated phenomena. And, therefore, whilst endeavouring as much as possible to extend the actual domain of mathematics, we must acknowledge that the most difficult sciences are, from their nature, destined to remain indefinitely in that preliminary state which in others precedes the epoch when they became accessible to mathematical theories. We must be content, as far as the most complex phenomena are concerned, to analyse accurately the circumstances of their production, to unite them to one another in some general manner, to discover the separate influence of each agent, &c., but without studying them under the relation of quantity; and, consequently, without hoping to introduce into the respective sciences, that high degree of perfection which procures for the simplest phenomena an appropriate mathematical treatment, either with reference to the precision of our knowledge, or what is perhaps still more remarkable, with reference to their co-ordination.

It was out of mathematics that positive philosophy first arose; and the science of method has the same origin. It was therefore naturally inevitable that when a similar mode of proceeding was extended to each of the other fundamental sciences, attempts should be made to introduce mathematical methods more largely than the phenomena admitted; and this has given occasion to depurgations more or less extensive, such as that effected by Berthollet in chemistry, in order to get rid of the false influence. But in the development of every science, the general positive method must undergo certain modifications determined by the phenomena peculiar to it, and thence results the special character of the science; it is only then that it assumes its true definitive character, which ought never to be confounded with that of any other fundamental science.

HIGGINBOTHAM'S PORTABLE RAILWAY GAS APPARATUS.

Fig. 1.

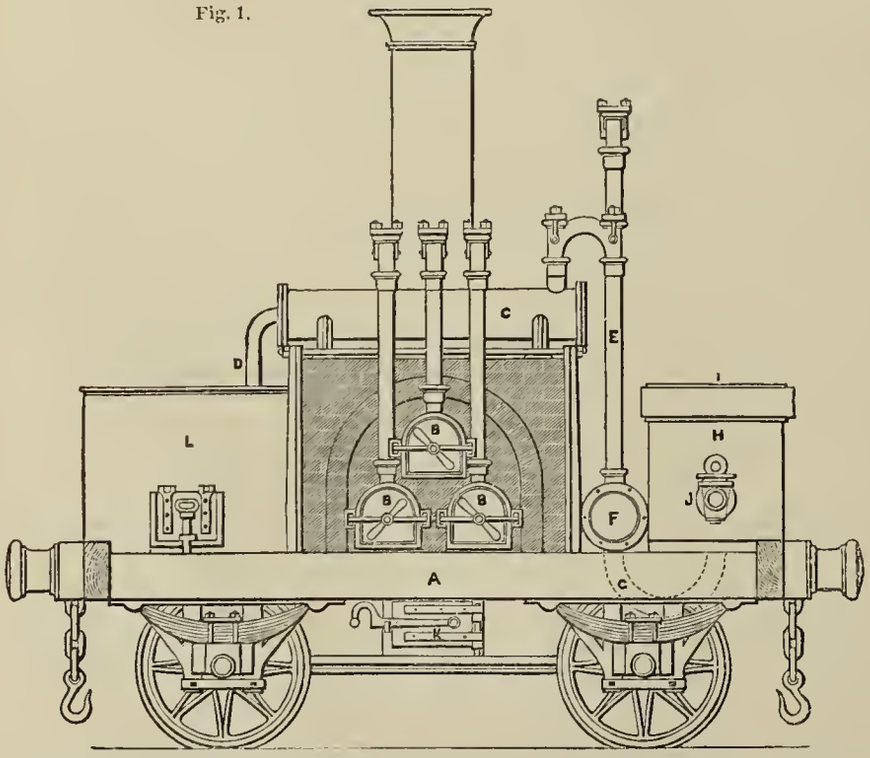
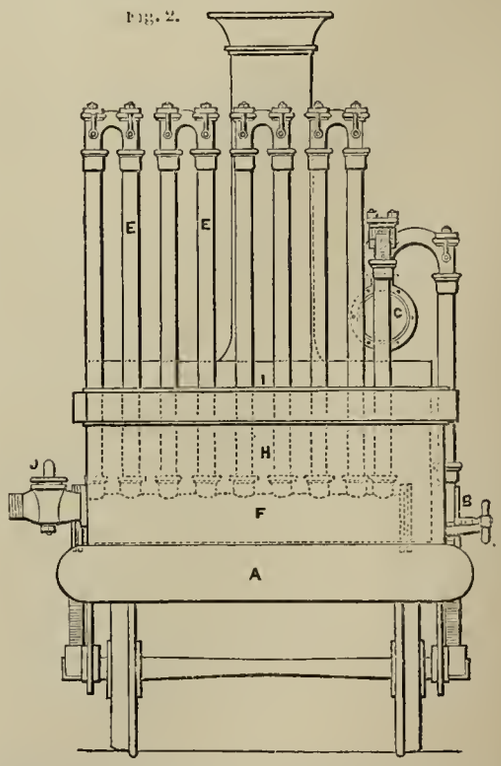


Fig. 2.



Mr. J. H. Higginbotham, of Manchester, who has done much towards the simplification and general improvement of the gas manufacture, more particularly with regard to the introduction of economical works on a small scale, for individual consumers, proposes the use, on railways, of a portable arrangement of apparatus, which may be easily conveyed on the line from one station to another, so as to obviate the necessity of

providing separate works for each. The plan which he advocates is characterised by considerable neatness and efficiency of detail, and appears to offer to railway companies the means of availing themselves of all the manifold advantages of gas-light, while it disencumbers them from the expense and difficulties of management attendant upon a number of isolated stationary works. The scheme will be easily made out from our engravings. Fig. 1 is a complete longitudinal elevation of the apparatus, as well in working as in locomotive order. Fig. 2, is a corresponding elevation at right angles to fig. 1, forming an end view. The entire apparatus is built in a strong cast-iron frame, on a truck, A, on four wheels, fitted with springs and buffers, as in an ordinary railway waggon. The bench of retorts numbers three, as marked B; and set in brick-work in the usual way, and transversely to the longitudinal centre line of the truck. In fact, the entire apparatus is nothing more than a common gas-maker, modified in its details to ensure perfect portability, and to fit it for erection upon a carriage-frame. The hydraulic main is, at C, communicating at one end, by the dip-pipe D, with the tar-well; and, at the other, with the set of vertical condensing pipes, E.

From the condenser, the newly-formed gas passes through the washer F, and thence through the curved pipe G, beneath, to the dry lime purifier H,—the products of condensation falling, meanwhile, to the bottom of the pipe H, and discharging by an inverted siphon. The purifier H, has a cover I, with an hydraulic joint, to allow of the ready renewal of the lime. At J, is a stop-cock, through which the purified gas passes off to the gas-holder. The retort furnace door is at K, in the centre, and the coal-bunker for the fuel supply, in which also is placed the tar-well, is at L.

When a supply is to be given off at any station, all that is necessary is to attach the pipe of the stop-cock, J, to the entrance main—the process of distillation being carried on, until the charge is worked off—and the apparatus is then removed, per rail, to the next station where the supply may be needed.

It is obvious that this plan may be judiciously adopted on extended lines of railway, so as to afford all the advantages so long sought to be obtained from "portable gas." The inventor states, that an apparatus of this class, capable of producing, with a six hours' charge, 2,700 cubic feet of gas, may be built for £200. The cost of production, including labour, he assumes at 1s. 6d. per 1,000 cubic feet.

THE CALCULUS OF PROBABILITIES.

An interesting article in a late number of the *Edinburgh Review* (which we believe we are not in error in attributing to Sir John Herschel), has called attention to a subject which, in its more intricate branches, belongs to the region of the higher mathematics. That it can be popularly treated, however, the excellent work of which the article professes to be a review, viz., M. Quetelet's "Letters on the Theory of Probabilities," and the article itself, are ample evidence, and we venture to think that a paper on the subject in this Journal may not be without its use.

We must always bear in mind that this theory is applied to events, not because they are uncertain, but because they are unknown. The theory being applied, in a state of imperfect knowledge, to the data in our possession, will furnish us with rules for acting in such a manner as to secure the best chance of success, because it enables us to select one out of several possible causes, or to track the path leading to an obscure consequence.

The Calculus of Probabilities is that important branch of mathematics which serves to render comparable the different hypotheses which may be formed, either as regards future events, or the causes of known events. "All events," says Laplace, "even those which, by their triviality, seem to fall under none of the great laws of nature, are nevertheless a consequence of those laws as necessary as the revolutions of the sun. The curve described by a single particle of air or vapour, is regulated in a manner as certain as the paths of the planets; there is no difference between them, except such as arises from our ignorance."

What we are to understand by *probability* has reference in part to this ignorance of ours, in part to our knowledge. If we know that out of three, or a large number of events, only one will happen, it is *probable* that any one of these events taken at pleasure will *not* happen, since several cases equally possible prevent its occurrence, whilst only one is favourable to it.

The measure of the probability of an event is the ratio of the number of cases favourable to the event in question, to the total number of possible cases. It is therefore represented by a fraction less than unity—unity being the symbol of *certainty* that it will happen, whilst zero is the symbol of certainty that it will *not* happen. Between these two points, that is the point where the impossibility of an event is, or seems to be, absolutely assured—and the point where its occurrence is as absolutely assured, there runs a scale, divided into an infinite number of degrees. Whilst this scale is necessarily the same for all persons, the degree selected to measure the probability of an event may be very different in different persons, because one person may have a completer knowledge of the facts of the case than another; and it is this knowledge that guides, or ought to guide, our conduct. Hence, a given degree of probability must be considered as peculiar to a given *person* at a given *time;* for not only may two persons, who take into consideration the probability of an event, possess different degrees of knowledge, but the same person may subsequently obtain additional information, which will induce him to assign a higher or lower degree to the probability he is desirous of expressing.

When the probability of an event is greater than $\frac{1}{2}$, then it may be considered as *probable*, for the favourable chances are more numerous than the adverse chances. When an event only admits of two possible cases, if one of these two cases has a probability greater than $\frac{1}{2}$, the other must be represented by a less fraction; and, therefore, we see how false was the assertion on which Pascal animadverts in his Provincial Letters, that two contrary positions may be both probable.

The very definition of probability proves that it does not at all depend upon the absolute number of favourable or possible events, but entirely on their ratio. In estimating probabilities, it is usual to compare events of different kinds to balls of different colours deposited in one or more urns, according to the laws wholly or partially determined by the enunciation of each question.

I. The sum of the probabilities of all the possible events is always equal to unity. Thus, when an urn contains black balls to the number of m, white balls to the number of n, and red balls to the number of p, the respective probabilities of drawing a ball of any one colour are expressed by the fractions

$$\frac{m}{m+n+p}, \quad \frac{n}{m+n+p}, \quad \frac{p}{m+n+p},$$

their sum being equal to unity.

Instead of an urn and balls we may use a solid, the sides whereof are formed by regular polygons to the number of $m+n+p$, the m faces being black, the n faces white, and the p faces red.

II. The preceding rule of calculation assumes that the cases are equally possible. If they are not, we must first determine their respective possibilities, of which the accurate appreciation is one of the most delicate points of the theory of probabilities; and the probability is then the sum of the possibilities of each favourable case. For instance, in the game of cross-and-pile, if we desire to ascertain the probability of throwing pile at least once in two throws, we can only reckon three different cases, namely,—*pile* at the first throw, and then a second is rendered unnecessary; *cross* at the first throw, and *pile* at the second; lastly, *cross* at both throws. D'Alembert, erroneously considering the three cases as equally possible, concluded that the required probability was $\frac{2}{3}$. But it is clear that the probability of throwing *pile* at the first throw is $\frac{1}{2}$, whilst the probability of the two other cases occurring is $\frac{1}{4}$; so that by virtue of the second principle, the probability is really $\frac{1}{2}+\frac{1}{4}$ or $\frac{3}{4}$. The same result is arrived at, by considering that the letters a and b can only be arranged in four different ways, viz.: aa, ab, ba, bb, and that three of such arrangements are favourable to the event of which we seek to estimate the probability.

The following example exhibits a new application of compound probabilities:—Each of several urns, the number whereof is a, contains m white balls, and n black balls; and of certain urns in number b, each contains p white balls, and q black balls. It is required to know the probability of drawing a white ball from some one urn taken at random. The probabilities of drawing a white ball from one of the urns of the first and second series, are respectively $\frac{m}{m+n}$ and $\frac{p}{p+q}$. The relative probabilities of putting our hand upon an urn of the first and second series, are $\frac{a}{a+b}$ and $\frac{b}{a+b}$. The compound probabilities of our drawing a white ball from either series, are therefore $\frac{am}{(a+b)(m+n)}$ and $\frac{bp}{(a+b)(p+q)}$, and the total probability is evidently the sum of these particular probabilities.

III. If the event is compound, that is, if it is composed of two or more events which are independent of one another, the product of their par-

ticular probabilities will give the compound probability, or the probability of their occurring together.

Suppose, for example, that a suit of 13 playing-cards is placed before us with their faces downwards, and it is asked what is the probability that the first two cards drawn shall be the ace and deuce. The probability of ace being the first played in a hand of 13 is of course $\frac{1}{13}$; when this is gone there remain 12, and the probability that the deuce should be played first is consequently $\frac{1}{12}$. Therefore, the probability of the concurrence of the two events will be $\frac{1}{13} \times \frac{1}{12} = \frac{1}{156}$ We may obtain the same result in another, though less simple manner. We know that the number of permutations of which 13 cards is capable, is $1 \times 2 \times 3 \times 4 \ldots \ldots 12 \times 13$. When two out of the 13 cards have a determinate place, there remains 11 others which may be arranged in every possible manner; that is to say, that the number of favourable chances is $1 \times 2 \times 3 \ldots . 10 \times 11$. The probability will consequently be equal to the ratio of these two products or to $\frac{1}{12 \times 13}$ suppressing the common factors.

IV. When two events depend on one another, the probability of the compound event is still the product of the probability of the first event, and the probability that the one event having happened, the other will also happen. Thus, let there be three urns, A B C, two of which contain white balls only, and one black balls only. The probability of drawing two white balls from B and C in succession is sought for. The probability of drawing a white ball from C is $\frac{2}{3}$; and if such a ball were really drawn, as the doubt would only exist between A and B, the probability of drawing a white ball from B would be $\frac{1}{2}$—consequently, the probability of drawing the white balls in succession from B and C is

$$\frac{2}{3} \times \frac{1}{2} \text{ or } \frac{1}{3}$$

V. If we propose to calculate *a priori* the probability of a past event, and the probability of an event compounded of that and another expected; the second probability divided by the first, will be the probability of the expected event, with reference to the event already happened.

Determination of probabilities in repeated trials at the same risks.—By repeated trials, we here mean a succession of events independent of one another, like the successive throws of the same number with similar dice, or the drawing of counters from an urn, replaced after each drawing, so as to preserve the same ratio of chances.

The probabilities of events of this class are first determined by the compound probabilities. For example, if it is required to know what is the probability of throwing C twice successively with a die of six sides, it is as if we sought the concurrence of two events the probability of each whereof is $\frac{1}{6}$. Therefore, for the probability sought we shall have $\frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$

The probability of not obtaining 6 in two throws is $\frac{5}{6} \times \frac{5}{6} = \frac{25}{36}$

The sum of these two probabilities is not equal to unity, because there is besides the case of 6 only turning up at the first throw, (the probability of which is $\frac{1}{6} \times \frac{5}{6}$) and the case of 6 only turning up at the second throw (of which the probability is $\frac{5}{6} \times \frac{1}{6}$.) The sum of all these probabilities is equal to unity:—

$$\frac{1}{36} + \frac{5}{36} + \frac{5}{36} + \frac{25}{36} = \frac{36}{36} = 1$$

By Newton's binomial theorem we may at once obtain all the probabilities of the different events which result from the successive throws of the same die; but as we desire to keep clear of the higher mathematics in this popular exposition, we shall not go farther into this part of the subject.

Law of Great Numbers.—Although the variable and unknown causes which we designate chance, render the progress of events, as long as we attend only to particular cases, uncertain and anomalous, yet when we take a more extensive survey, we shall often discover a striking regularity. Let us for instance take an urn containing white and black balls, and suppose we replace after each drawing the ball we took out, the ratio of the number of white balls drawn to the number of black balls drawn will generally at first be extremely irregular; but the variable causes of this irregularity mutually destroying themselves in the course of a large number of drawings, allow us after a while to perceive the ratio of the white to the black balls contained in the urn, or the respective possibilities of drawing each time a ball of either colour.

This particular example will serve to explain a proposition, conformable both to common sense and to experience, whereof the demonstration, which presented great difficulty, was first given by James Bernouilli. The proposition is this:—We may always assign a number of trials, such that the result will give a probability approaching certainty as nearly as we desire, and so that the ratio of the number of occurrences of the same event to that of the trials, shall not deviate from the simple probability of that event beyond given limits, how narrow soever these limits may be made. In Sir John Herschel's language—Probabilities become certainties when the number of trials is infinite, and approach to practical certainty when very numerous. Hence this remarkable conclusion, viz., that if an exceedingly large number of measures, weights, or other numerical determinations of any constant magnitude be taken—supposing no bias or any cause of error acting preferably in one direction to exist—not only will the number of small errors vastly exceed that of the large ones, but the results will be found to group themselves about the mean of the whole, always according to one invariable law of numbers; and that the more precisely, the greater the total number of determinations.

Again, the theory is to be regarded as a practical auxiliary of the inductive philosophy—for it is found that the ratios of the phenomena of nature are almost constant, when a great number are taken into consideration. Thus, notwithstanding the differences between single years, the sum of the productions of a country during a similar number of years, provided that number is considerable, is almost the same. Again, in spite of the variations in temperature of the same season in different years, the temperature of entire years varies little from the same amount. The use of the theory in this way (remarks Sir John Herschel) depends on that mutual destruction of accidental deviations from the regular results of permanent causes, which always takes place when very numerous instances are brought into comparison. Examples might be multiplied indefinitely in every department of practical inquiry. Indeed, every phenomenon which nature offers on the great scale may be regarded as such. Nay, many of the effects arising from moral causes are subject to this law of great numbers. The proportion of births to the population, and of marriages to births, is liable to very inconsiderable variation. It is to this application of the theory of probabilities that M. Quetelet's excellent work relates. He has brought together a great number of highly interesting facts, and he shows how extremely valuable are continued and accurate observations, when extended over long intervals of time, and large numbers of phenomena. Curious and quite unexpected results come out, connected with a degree of precision and uniformity, utterly contradicted when only a few phenomena are looked at.

The probabilities of drawing an even or uneven number from any heap composed of m pieces, are respectively expressed by the fractions

$$\frac{2^{m-1}-1}{2^{m}-1} \quad \text{and} \quad \frac{2^{m-1}}{2^{m}-1}$$

All games may be considered equitable in which the players stake sums proportional to the number of chances by which they can gain. If we give the term of *mathematical expectation* to the probability multiplied by the gain which each player can hope for, or the stakes of the other players, the preceding principle may be expressed by saying, that on beginning to play, the mathematical expectations of the players ought to be equal. When some of the players withdraw before the game is at an end, the partition is governed by a new principle, viz., every player loses a right to the money which he laid down, but in return gains, upon the pool or stock of the game, a right proportional to the probability which he has of winning that stock. When the mathematical expectations are not equal, then, by virtue of the law of great numbers, the gain of one of the players ought to go on increasing, and we can always find a number of trials in which the probability will reach a determinate sum approaches certainty as nearly as we choose. However, it ought to be subjoined, that even when the chances of the game are equal, a prudent man will not risk a large sum in the hope of a small but probable gain; he will rather stake a small sum to win a considerable gain, with few probabilities in his favour. Hence we must distinguish between moral expectations and mathematical expectations. If two men were to play (says Buffon) for their whole property against each other, the effect would be that the one would do no more than double his fortune, whilst the other would lose the whole of his. What proportion is there between the loss and the gain? The same that there is between all and nothing; the gain of the one is but a moderate sum; the loss of the other is numerically infinite, and morally so great, that the labour of the rest of his life may not restore his property.

Mean Results; Method of Least Squares.—One of the most useful applications of the law of probabilities consists in the discovery of the

most probable truth, when the observations have yielded different results. In the simplest case of all, where the determination of a quantity only depends upon several observations of a single fact, we may take the arithmetical mean of the observations, that is, the sum of the figures given by the observations, divided by the number of the observations. For example, if three persons observe a rapid burst of meteoric phenomena, and, attempting to count them, arrive at the numbers 22, 23, and 27, it is certain that all cannot be right, and it is probable that all are wrong; for adding the numbers together, and dividing the sum by the number of observers, we get the figure 24, which more probably represents the true number than that given by any single observer. Assuming this to be so, we shall have errors to the amount of 2, 1, and 3, respectively—the squares of which (4, 1, and 9), when added together, make 14, the least possible sum thus obtainable. Take another example—a person counts a quantity of coins in a hasty manner, and believes they amount to 89; going over them again with no more care, he finds them to amount to 93; a third hasty enumeration gives him 97—summing these figures together, and dividing by three, the number of the trials, we get 93 as the mean, and this is probably the truth. The result of the middle trial was therefore right, and the result of the two other trials, severally divided, 4 from the truth. Now, were we to assume any other number than 93 to be the true one, the sum of the squares of the errors would in that case exceed 32, the sum of the squares of 4. This, the principle of least squares, as it is termed, may be applied to far more complex cases than these, but the rule is the same in all.

THE AUTOGRAPHIC PRESS.

Messrs. Waterlow & Sons, the lithographers, of London Wall, are the inventors of, and are now introducing, a method of printing copies of MSS., drawings, or designs, simple and manageable enough to be within the reach of ordinary business men, or counting-house clerks. Ordinary lithography, although invaluable for most purposes where great quantities of impressions, from one original, are required, can only be practised by skilled lithographic writers and printers, and is quite beyond the power of non-professionals. It is, then, to give every individual copyist a means of multiplying the productions of his pen or pencil, that Messrs. Waterlow have addressed themselves, with an amount of success which, to those who comprehend the difficulties of the pursuit of the lithographic art, appears somewhat wonderful.

The process of taking copies of any circular, letter, piece of music, or pen-and-ink sketch, is very simple. The subject to be printed, is first written or drawn on autographic paper with autographic ink: the paper is then wetted on the back and laid face downwards on the plate, and the tympan or cover being laid over it, the pressure is easily applied by means of a scraping-bar grasped firmly with both hands. This pressure forces the moisture through the autographic paper, and causes the composition with which it is prepared to leave the paper and adhere to the plate, and with it the autographic ink, which having an affinity with the metal of the plate, adheres so firmly to it, that the composition may be washed off the plate with a wetted sponge, leaving the subject transferred to the plate. A preparation is now applied which etches the plate, and prevents it from taking the ink where it is not required. This preparation is wiped off with a damp cloth, and the inking-roller being passed over the plate, the subject becomes charged with ink, and the paper on which it is intended the copies should be taken, being laid on the plate, the tympan is placed down and the pressure applied as before. One impression being taken, the plate is again damped with the cloth, and charged with ink, the paper laid down as before, and in this manner thousands of perfect copies may be printed.

The novelty in this invention consists in the printing-press being reduced to the simplicity of a metallic plate, and its tympan, which fastens itself on the table at which the work is performed—the materials being somewhat similar to those employed in lithographic printing.

The patentees also claim other methods of taking copies of any document; but as these require a peculiar and more complicated form of press, and consequently will not become of such general use, we need not proceed to describe them.

The credit of the invention rests principally upon the means adopted for bringing lithographic printing into more general use in the production of duplicates on a small scale. We have seen some excellent specimens of the work printed by the process just described, and printed well—some at the rate of 50 impressions an hour. One is a bold sketch of river scenery, with foliage and buildings, executed in a broad expressive style in chalk. Another is a sheet of music. All are clearly printed, and, so far, are good evidences in favour of the autographic system. If the details can be sufficiently easily managed to admit of the student, the traveller, or the man of business, producing copies at once, as they may be wanted, without a lengthened amount of practice, the invention may be considered of the greatest value.

HYGROMETER FOR REGULATING THE MOISTURE OF THE AIR IN CLOSED APARTMENTS.*

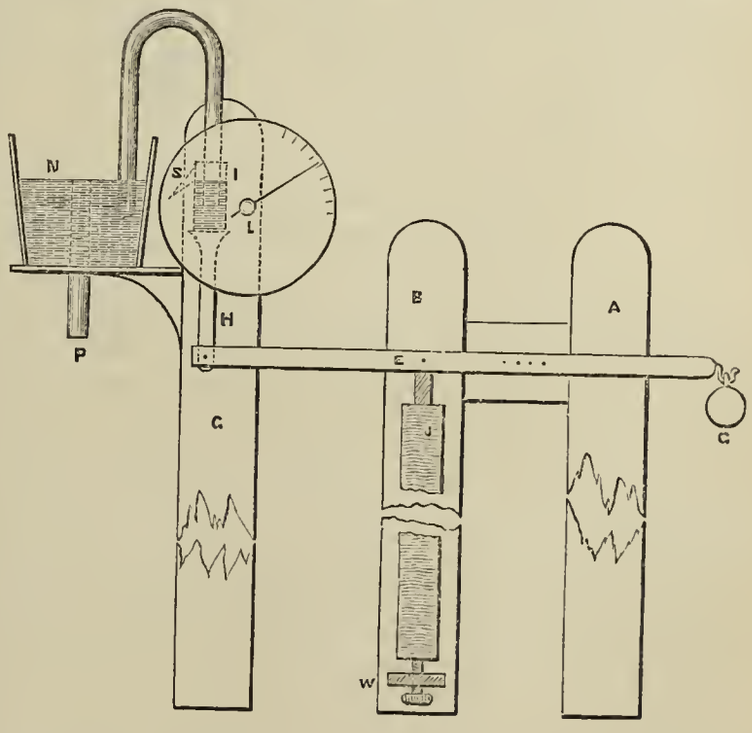
By John M. Batchelder.

In a letter of Franklin, addressed to Edward Nairne, of London, a plan for an hygrometer is mentioned, which was afterwards made by Mr. Nairne, and is described in vol. iv. page 449 of Sparks's edition of Franklin's Works.

In this instrument the motive power is derived from a slip of wood, one end of which is fixed, and the other end attached to the short arm of a bent lever, which is moved by the expansion and contraction of the wood, the extent of the motion being shown upon a graduated arc at the extremity of the lever.

Having found that an hygrometer resembling this, which I have used for several years past, is very readily affected by changes of moisture, I have made one upon a similar plan, and attached to it an apparatus which will produce any required degree of moisture in the apartment in which it is placed. An instrument of this kind will not indicate the dew-point with accuracy, neither can two instruments be made to give precisely the same expansion or contraction when exposed to the action of the same degree of moisture; it is, therefore, of no value for observations that are to be recorded and compared with each other, but each instrument, when used in conservatories, or in any place where the temperature is nearly uniform, will, if the air becomes too dry, restore it to that degree of moisture that has been previously determined upon as the most desirable.

In the annexed figure, A, B, and C, represent standards of wood which support the apparatus; E is a lever having its fulcrum at F. Upon the top of the perpendicular rod H, which rests upon the horizontal lever, a light open-mouthed vial or cup, I, is placed, having an orifice and lip, S, at its side, near the top; this contains about one gill of water, its weight and the weight of the long arm of the lever being balanced by the counterpoise G. J is a slip of bass wood (Tilia Americana), four feet in length,



two inches in breadth, and one-eighth of an inch thick, the grain running in the direction of its breadth, or horizontally. This wood should be perfectly sound, of straight grain, but not of very close texture, its exterior being made rough by the use of coarse glass paper, in order to expose a larger surface to the air. At the bottom of the standard B, is a nut and adjusting screw, W, to which the slip of bass wood is attached; a plate of brass is screwed to the top of the wood, and is fastened by a pin to the lever E; from this lever a silk thread is carried around the pulley L, in a spiral groove; the axis of this pulley passes through a dial plate and carries an index. At N is a vessel of water, having a pro-

* From the Franklin Journal.

per supply pipe leading to it, the water being retained at a uniform level by the waste-pipe P, and connected with the water in a small vessel by a syphon. The respective length of the legs of the syphon is immaterial, as the flow of the water depends upon the relative level of the surface of the water in the reservoir, and that in the cup; both legs being immersed, the syphon remains constantly filled with water.

To put the instrument in operation, let the apartment be kept at its mean temperature, and at the degree of moisture required, both of the vessels and the syphon being filled with water. After the instrument has been exposed to this atmosphere a short time, turn the screw at W until the orifice in the vessel I is level with the top of the waste-pipe P; then turn the pulley L, and set the index at zero. The instrument being thus adjusted, if the air becomes more dry the slip of wood contracts, the small cup descends, and water flows into it from the stationary reservoir; the water then escapes from the orifice in the side of the cup, falls into a funnel, and thence into a pipe, which, when the instrument is used in green-houses, conveys the water to evaporating pans placed upon the flues, or to a horizontal pipe, having openings at its upper surface at suitable intervals, from which the water falls at any point desired. As the water thus discharged evaporates, the surrounding air is moistened, the wood is expanded, and when it attains its original length, the orifice in the cup is again raised to the level of the surface of the water in the reservoir, and the flow of the water ceases. If, from any cause, the air should become too moist, the only effect produced is, that the cup continues to rise, and a small quantity of water flows back to the large reservoir.

If, by accident, the air should become very dry, the further contraction of the wood causes a larger quantity of water to issue from the cup than is due to this change in the hygrometric state of the air, the discharge being *accelerated* as the difference of level between the two surfaces increases; thus the return of the air towards its normal condition is the most rapid at the time when it is of the most importance that the moisture should be restored. The same degree of moisture may be made to discharge a greater or less quantity of water, by moving the fulcrum of the horizontal level to the right or to the left.

The opening and closing of valves and stop-cocks is attended with much friction, but in this instrument, it will be observed that the water flows through the syphon with a very small amount of friction, and that little power is required to depress the cup. This plan may, therefore, be used to advantage in many instruments in which the motive power is small, the weight of the water discharged being applied to produce more extended or more forcible movements.

THE GEOLOGY OF THE OCHILLS.

By Mr. R. Smith, Blackford.

III.

Our last paper concluded with a brief geological account of the northern boundary of the Ochills, we may now therefore turn to the southern division, which is still more interesting, being replete with the entire range of the primary, transition, secondary and tertiary formations. In this quarter is situated the great and only coal field north of the Frith of Forth, extending over a considerable portion of the shores of Clackmannan, Perth, Kinross, and Fife. Like the other coal deposits of Scotland, this field affords great varieties of the fuel which has done so much for us as a commercial nation.

Of the primary origin of coal there is but one opinion amongst scientific geologists, but various hypotheses have been advanced to account for the peculiar processes involved in its production in the bowels of the earth. Little doubt however can exist as to the formation of brown and mineral coal, from the remains of the members of the vegetable kingdom which flourished in splendid luxuriance, on the plains of a former world. A great portion of the deposit here is of crystalline form, and it is probable that this phenomenon has arisen from the action of mineral waters containing arsenic, iron, and sulphur, combining with the carbonaceous substance of the drifted vegetables, after the latter have undergone the processes of decomposition which we now term decay and putrefaction. The carbonaceous matter, after being rendered soluble, is deposited from the water in combination with these mineral substances in a crystallized state, forming what is called mineral coal. In support of this hypothesis, the fact may be adduced that mineral coal is invariably found to contain a quantity of the three substances above-mentioned, and indeed they are generally found in large quantities in the vicinity of the coal formation. In this district also, ironstone is met with in abundance; the principal ores being iron pyrites, and carburet of iron, known amongst practical miners as the "black band," and worked with great success for the supply of the raw material to the furnaces of the neighbourhood. Carburet of iron is strongly analogous to coal, the only essential difference being the preponderance of metallic matter in the former, so that both may be assigned to the rank of vegetable matter—the one with a maximum, the other with a minimum, of iron. Thus, in effect, all the varieties of coal with which we are acquainted, are to be considered as forming a series of carburets of iron, with constituents in various proportions.

The carbonisation of vegetable matter by the action of, or combination with, iron, may be illustrated by depositing a piece of wood, or the leaf or stem of a plant, in a solution of a salt of iron, and allowing it to remain for several months, when very good evidence of the action will be produced. If decayed wood is used, the effect will be seen in a much shorter time than with sound materials. If the solution containing the wood is exposed to heat, as in an oven, the process will also be accelerated. Many opinions go to the effect that, through the course of ages, coal undergoes a series of changes, from the drifted vegetable matter becoming a mass of bog, abounding in wood and plants of various kinds, which have been buried in the earth to a considerable depth by nature's aqueous convulsions; and, in process of time, the continuous action of mineral waters, heat, and the pressure of the superincumbent mass, converts it first into fire-coal, then gas-coal, and lastly iron-stone. The precise mode in which the effect is produced—whether by a series of changes from one state to another, or by the vegetable matter being placed in various situations, and exposed to the influence of water impregnated with various chemical agents—may remain for a long period, or perhaps for ever, unknown to us; yet it is certain that mineral waters —particularly those denominated chalybeates, which contain iron—perform an active and very important part in the natural chemical process of transmutation.

At Vicar's Bridge, on the east side of the river Devon, the rocks are chiefly sand-stone of the secondary formation, containing strata of lias, lime-stone, iron-stone, and fire-coal, comprising numerous fossil shells and plants. The water oozing out of these layers is largely impregnated with mineral matter—that from the iron-stone containing sulphate of iron, and that from the lime-stone carbonate of lime. Here the curious inquirer will be gratified by seeing performed, in nature's laboratory, a beautiful chemical experiment which is often exhibited to admiring witnesses in the artificial laboratory. At a number of places in the perpendicular face of the rock, the water holding in solution the sulphate of iron, mingles with that containing carbonate of lime, and the sulphuric acid of the sulphate of iron, combining with the lime of the carbonate, forms sulphate of lime, part of which is precipitated on the surface of the rock, whilst the remainder is carried along with the current to the bottom. After the lapse of ages, this deposit will have formed a rock of gypsum (alabaster), which geologists of a future generation may admire and examine, whilst they theorise on its origin.

In this rock there is also an old mine containing a chalybeate spring, at one time used medicinally, but has now suffered neglect for a long period.

In the plantation on the south side of the bridge is another mineral spring, the water of which, according to the analysis of the author, contains in a fluid ounce:—

	Grains.
Sulphate of iron,	4·25
Sulphate of alumina,	2·17
	6·42

with a trace of manganese and lime.

This likewise presents an interesting phenomenon: the water, as it flows from the fount, spreads over the bank, depositing a copious supply of oxide of iron, which mixes with the grass and mosses on the surface of the ground; and the decayed branches and foliage which fall in autumn from the trees, will doubtless form, in time, a mass of ironstone. When a fragment is broken away from the crust already formed, it is easily perceived that the plants which are mixed with the ochreous matter have undergone the process of carbonization, which is a striking illustration of what has been formerly said in reference to the coal and ironstone formation. This, like the gypsum, may form a subject of inquiry for chemists and geologists yet unborn.

At a distance of about three miles from the place, coal-mines were at one time extensively wrought, near Dollar and Blaringone. The sandstone and lias layers above the coal are here exceedingly rich in organic remains, as Stigmaria Ficoides, Ferns, Acquisitacæ, and Sigillaria. Numerous specimens of fossil plants have also been found in good preservation in the Cleish and Sherdale quarries. These are chiefly pines, palms, canes, reeds, and arborescent ferns. At the latter place is to be seen a beautiful illustration of the theory that the residuum of the waters of a primeval ocean has been changed into masses of stone, for here we can distinctly trace upon the rock the marks of the undulating waves,

even to the ripple of the surge which lashed the strands of an antediluvian world.

The best specimens of fossil shell-fish obtained in this district are found in the limestone rocks of Rathscobbie, although they are by no means searee in many other quarters. A little to the west of Birch-hill-end, on the banks of Black Devon, is a magnificent ravine, the steep banks of whieh are covered with wood, whilst closc to the water's edge, on the north bank, rises a perpendicular rock of considerable height. At the bottom, and near the centre of this, is a pool of bright clear water, possessing the power of changing organic matter into stone. Mr. David Hind, of Dollar, discovered pctrifactions at this place many years ago, and to him the author is indebted for the knowledge of the fact.

When the author visited the locality, a few weeks back, for the purpose of obtaining the details now given, he found, that of the mosses and lichens growing in the sides of the pool, the part exposed to the influenec of the water was quite petrified, whilst the rest, out of contact with the liquid, was quite unacted on, having all the verdancy of plants growing under ordinary circumstances. On a chemical examination, the watcr was found to contain a large quantity of carbonate of lime, with tracts of oxide of iron and alumina; consequently, in its circulation through the plants, a portion of the lime is deposited in and around the stems and leaves, and in due time the entire organic matter is decomposed, being replaeed by the lime, so as to form plants of stone, retaining all the external shape of the living vegetable. Since the publication of the last paper on the "Geology of the Ochills," a fine saline spring has been discovered in the side of the trap dyke formerly noticed. It is about a quarter of a mile east from St. David's, Madderty. At the request of the Rev. John Clark and David Ross, Esq., Surgeon, R.N., the author analysed this water, and found an English pint to contain -

	Grains.
Chlorate of soda,	22·29
Chlorate of lime,	30·31
Sulphate of magnesia,	12·
Sulphate of lime and soda,	1·52
Carbonate of lime,	0·53
Oxide of iron,	0·51
	67·16

with traces of bromide of magnesium, and iodide of sodium.

By a comparison with springs of a similar character, it will be seen that this is the strongest saline spring hitherto found in this part of the country. Its medicinal properties are highly spoken of by those who have tested it, so that it promises, ere long, to become a well frequented spa.

A CONTRIBUTION TO THE HISTORY OF COTTON SPINNING. THE AMERICAN OR "NIAGARA" THROSTLE.

It was only in our last number that we had occasion to remark upon the vast amount of ingenuity frequently expended, with indefatigable earnestness, upon an apparently simple and unimportant object, as evidenced in the variety of schemes which have been developed in the mule, for "taking in the earriage," and "winding the yarn upon the spindles to form the cop." How much more, then, have we cause for expressions of wonderment and admiration, when we look a little further into the endless ramifications of our textile manufactures! If we examine the spindle motion alone, as it exists in one branch only of its numerous applications—the "throstle"—our utmost notions of the possible variations of this single movement fall far short of the extent of the modifications with which we meet. Numbers of these arise from mere fancy, or a passion for novel contrivanees; and few only are based upon practieal notions of economy, excellence, or speed of production.

The spindle movement, in what is commonly termed the "Niagara" throstle, which forms the subject of our short "Contribution to the history of cotton-spinning," has met with the support of a good many of our practical men; and as it has now been tolerably well proved, and is in some quarters gaining ground, its peculiarly ingenious action may be not inappropriately detailed here.

Our engravings represent, in fig. 1 a front elevation of the movement, as it appears when the observer stands in front of the throstle-frame, and fig. 2 is a corresponding side view. The spindles, A, are fixed, having no movement whatever, being held vertically by set screws in the deep sockets, B, of a line of short brackets projecting from the main framing to the line of the spindle centres. For about two-thirds of the entire length from the top, the spindle is regularly cylindrical, this portion being terminated by a slight collar, beneath which the spindle is again a plain cylinder, but of increased diameter, to the bottom. The dotted lines, in both figures, represent the exact shape, the lower thick end of the spindle being passed through a cast-iron boss, C, upon tho upper face of which the bobbin, D, rests loosely. At E, a leather washer is screwed up by a shallow nut to the bottom face of tho boss, this nut forming the resting surface upon the top of the eye, B. This leather washer is the friction surface, by means of which the bobbin is driven from the periphery of the plain narrow pulley, F, on the horizontal driving-shaft, G. This shaft and line of pulleys takes the place of the drums, warves, and

Fig. 1.

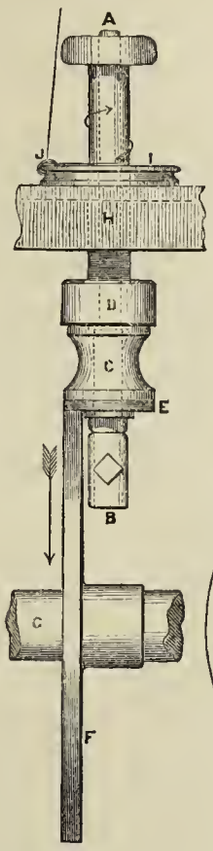
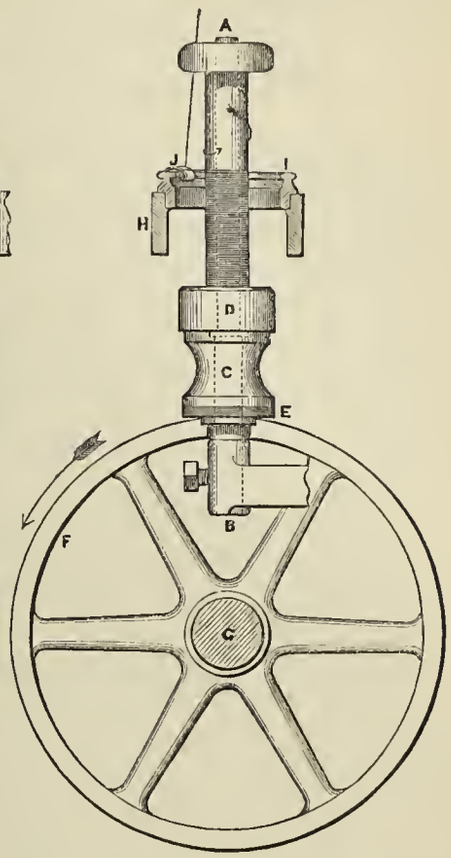


Fig. 2.



Scale one-third.

banding of the common throstle, the shaft passing along the front of the frame, and presenting no other mechanism than the line of smooth pulleys. The spindle merely forms a steady centre for the revolution of the bobbin, its collar being sunk into the top face of the boss, C, which has a projection to carry round the bobbin in the manner well known in other branches of cotton mechanism. H, Is the copping rail, having sunk in its upper surface the "ring," I, to carry the "traveller," J, which is merely a bit of flat steel, bent to a loop, grasping the flange on the upper edge of the ring, leaving space as well, for the passage through of the yarn, as it issues direct from the delivery rollers and proceeds to the bobbin.

To those whose ideas are confined entirely to the flyer action for spinning and winding-on, it will appear rather strange that, by the mere traverse of the copping rail, carrying the "rings" and "travellers," and the regular revolution of the spindles, the yarn is spun and laid uniformly and firmly upon the bobbins. The ring, I, being fixed, answers the office merely of a guide for the revolution of the traveller, which is carried round by the yarn as the bobbin revolves—the winding-on being effected entirely by the drag of the traveller in its passage. Generally two travellers are put on the ring, so as to afford a relay when breakage ensues. They are numbered, and made of different weights, to suit the varieties of yarn to be spun, as it must be obvious that finer or coarser yarns will experience a correspondingly varying effect from the drag of the traveller.

The presumed advantages of this movement are,—short fixed spindles, the absence of objectionable friction, uniformity of winding-on, and increased production; and all these, we believe, it possesses in a greater or less degree. But it is not the mere detail of the contrivance, or its superiority of action, which forms the subject of our "contribution." We have, in addition to this object, to remind our readers, that Mr. Bodmer invented and introdueed a ring and traveller action, on a similar principle, in his "bastard frame," which formed the subject of his patents in the years 1838–42. We mention this, because, in the lapse of years, the originator of the idea appears to have been overlooked amidst the numbers of subsequent modifiers and improvers.

The throstle from which our sketches were taken, was made by Messrs. Sharp of Manchester, and is now working at the mill of Messrs. Johnston and Galbraith in Glasgow.

The application of the friction-pulley-driving apparatus is the American share of the invention, having been patented in that country several years ago by a Mr. Dodge—and subsequently, on his behalf, in this country—where, as we have previously stated, it is known by the quaint distinctive name of the "Niagara" throstle. We have before us some further improvements both in this and in the common throstle, which we shall shortly be able to illustrate and describe.

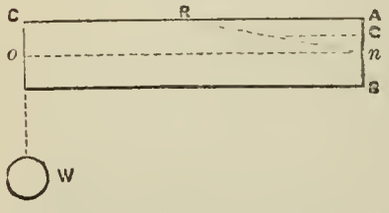
ON THE STRENGTH OF TIMBER.*

By Herman Haupt, Esq., C.E.

About twelve years ago I became very much interested in calculations upon the strength of materials, but my location at that time—as engineer on a small railroad in the interior of the state—not affording me facilities for consulting any of the standard writers whose works might have thrown light upon the subject, I had recourse to experiment and observation, in order to satisfy myself in reference to the mode of distribution of the strains, and to determine the formulæ for calculating their intensities. A little reflection led to the application of a principle, which appears to be different from any that has been employed by others, for the determination of the ordinary algebraic expressions which represent the strength of different forms of beams, and appears so simple and easy of application, and at the same time so readily deduced from the elementary conditions of resistance, that I will take the liberty of troubling you with a brief explanation of the principle itself, and its application to some of the ordinary cases which occur in practice.

The first fact which has been established in the resistance of beams laid horizontally upon two supports, or fixed at one end and loaded with a weight applied at the other, is, that the fibres on one side are compressed, and on the other side extended. It is also a consequence of the elasticity of the material, that, within the elastic limits, the resistances to extension and compression must be sensibly equal, and that a certain line exists, called the neutral axis, along which neither extension nor compression will be found, and which retains its natural condition. It is also evident that, in a material which is perfectly homogeneous, the strains upon the fibres will vary uniformly from the neutral axis to the most distant fibres. These conditions naturally lead to the following mode of calculation:

Let A C represent a beam fixed at A, and loaded with a weight, W, applied at C, $n\,o$ represents the neutral axis. The fibres on the side, n A, will be extended, and those on the side, n B, will be compressed, and their resistance must be sufficient to keep in equilibrium the weight, W.



If A B C represents a section of the beam by a vertical plane, we may conceive the strain upon the fibre, A C, or its equivalent resistance, to be represented by some line, A R; and as the strain at n is nothing, and is supposed to vary uniformly from n to A, it follows, that if n and R be joined, forming a triangle, the strain upon any intermediate fibre will be represented by the corresponding perpendicular of this triangle, and the whole strain, equal to the sum of all the perpendiculars, by the area of the triangle. The effect of this triangle of resistance would be equivalent to its whole area concentrated at its centre of gravity, and acting with a leverage equal to the distance of this point from the neutral axis.

This principle furnished a key to the solution of all the problems which are presented in calculations upon the strength of materials; it was found to be susceptible of general application. Some of the solutions require the aid of calculus, but in general they are extremely simple. The case of a rectangular beam fixed at the end will serve as an illustration.

Let the maximum strain upon the fibre A C be represented by R. Also,

b = breadth of beam in inches.
d = depth of beam in inches.
l = length in inches.
W = weight applied at C.

The area of the triangle A R $n = \frac{\mathrm{R}\,d}{4}$. The distance G $n = \frac{1}{3}d$. The effect of the triangle of resistance will be $\frac{\mathrm{R}\,d}{4} \times \frac{d}{3} = \frac{\mathrm{R}\,d^2}{12}$. The resistance of the fibres n B will be also equal to $\frac{\mathrm{R}\,d^2}{12}$, and the whole resistance will be $\frac{\mathrm{R}\,d^2}{6}$. The effect of the weight W, acting with a leverage l, will be W l, and the equation of equilibrium will be $\frac{\mathrm{R}\,d^2}{6} = \mathrm{W}\,l$.

In this expression the breadth of the beam has not been introduced, the calculations having been made upon a vertical section, but if the breadth be considered, the triangle becomes a wedge, and the centre of gravity remaining at the same distance as before, the only change in the expression results from the introduction of this term, and it becomes—

$$\frac{\mathrm{R}\,b\,d^2}{6} = \mathrm{W}\,l, \text{ or } \mathrm{R} = \frac{6\,\mathrm{W}\,l}{b\,d^2},$$

An expression which is identical with those obtained by Tredgold and others by different processes.

If the beam should be placed in such a position that the diagonal of the cross section would be vertical, the solid which would represent the resistance would become a triangular pyramid, instead of a wedge as in the case just considered.

If the resisting material should be in the form of a cylinder, the case would present greater difficulty, but is susceptible of solution on precisely the same principle, the solid of resistance in this case being an ungula.

* *Franklin Journal.*

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RECENT PATENTS.

TURNING AND CUTTING WOOD.—Joseph Findlay, Paisley. *Enrolled October* 5, 1850.

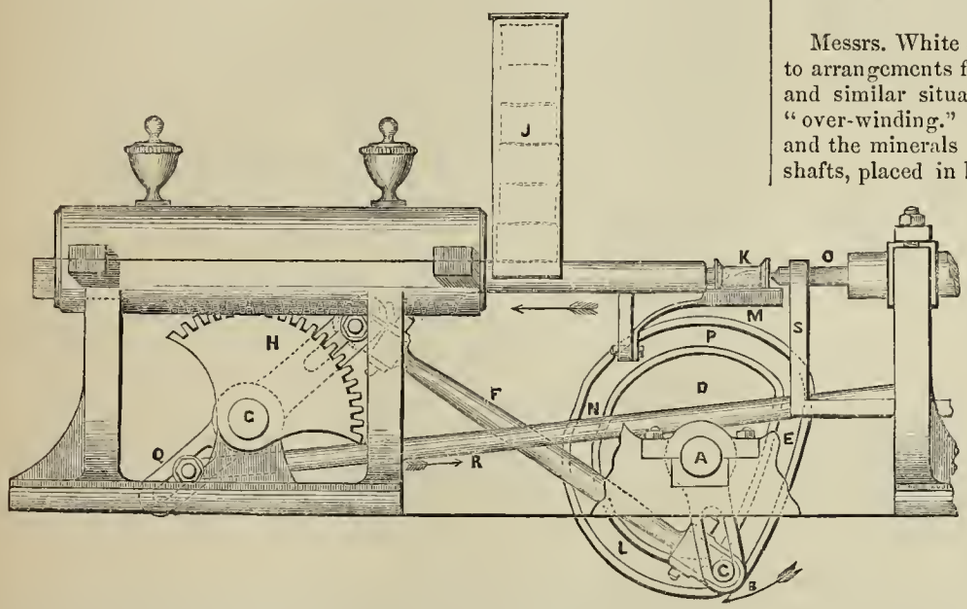
We have already fully illustrated* Mr. Findlay's ingenious machine, as applied for the purpose of turning bobbins, under two or three different modifications. The arrangement under the present patent is a very considerable improvement upon the earlier plan, inasmuch as in it, the whole of the several movements, including the feeding of the blanks, and placing them on the mandril, the removing of the finished bobbins, and the stop movements of the cutters, and the traversing bar for bringing up and holding the blanks upon the mandril, are all self-acting. To those who have read our previous description, it will be unnecessary to detail more than the mode in which these movements are made automatic, and for this purpose the annexed engraving will be a sufficient illustration. This view is a front elevation of one of the headstocks, with the actuating mechanism for the whole of the movements. The headstocks stand as before, and the mandril carrying the bobbin blank, is driven in the ordinary way by a strap, direct; but the rest of the movements are actuated by the transverse shaft, A, which has upon it two scroll pulleys, or short cylinders, having endless differential spiral grooves cut on their peripheries, so as to produce a species of irregular right and left spiral in one continuous length. Each tool-holder has a pin projecting from its lower surface, down into the spiral groove of its corresponding scroll pulley, so that the continuous revolution of the shaft with its two pulleys, in one direction, traverses both holders back and forward to the extent of the run of the spirals. The action of these spirals is such as to give the tools a quick traverse when out of cut, and a slow one during the time they are actually forming the bobbin, the cutting action being at the termination of the stroke, just when the pins of the holders are passing the points where the right and left spirals join at their inner ends. The junction of the opposite ends of the spirals is effected by a straight portion, cut at right angles to the axis of the scroll pulley, and joining up to the spirals by quick curves; the object of this contrivance being to allow the tool-holders to come to a stop when drawn back for the adjustment of a fresh blank.

The main shaft, A, projects behind the two scroll pulleys, and carries upon its end a slotted crank-lever, B, motion being given to the shaft by

* Plate 51, vol. III.

the belt-pulley, D. The pin, C, of the lever, passes transversely through the slot, projecting far enough on each side to enable its ends to enter the differential grooves, E, L, N, P, in the inner faces of two vertical disc plates, bolted down to fixed standards behind the headstocks. The pin, C, also passes through the eye of a connecting rod, F, the opposite eye of which is jointed to a pin adjustable in any fixed position in the slot of a crank-lever, keyed on a second horizontal shaft, G. This shaft has upon its front end a toothed segment, H, the teeth of which project through a slot in the lower side of the adjustable headstock, and gear with rack teeth formed on the lower side of the traversing bar, I.

The blanks for the bobbins are fed into the open top of the vertical supply channel, J, one above another, forming a column, as represented



by the dotted lines. This channel, or case, is held in a fixed position, immediately over the centre line of the traversing bar, I, by a bracket, and is open at both ends, the bottom one being grooved out to fit loosely over the bar which traverses beneath it.

In the engraving, the machine has just completed a thread bobbin, K, which is about to be removed from the mandril, in readiness for the supply to the latter of a fresh blank from the pile or column in the case, J. The pin, C, travelling in the direction of the arrow, is just about to enter the concentric portion, L, of the differential grooves, and this portion being curved to a radius equal to that of the crank, B, when the pin is at the extreme outer end of its slot, it follows that the crank communicates its full effect to the connecting-rod, F, at this point of its travel. In this way, the bar, I, is traversed outwards in the direction of the arrow, to release the finished bobbin, and take on a new blank.

A projecting bar is fastened to the lower side of the bar, I, to carry a small bracket or cup-rest, M. The bar is moved outwards until the cup comes beneath the case, J, when the lowest blank of the series drops off the top of the bar into the cup. To allow time for this movement, the grooves in the disc plates are formed as represented at the part N, being curved inwards toward the centre to a radius equal to the length of the connecting rod, F, so that when the pin, C, arrives at this point, it traverses through the curves without communicating any motion to the bar, I; the slot in the crank, B, allowing the pin to traverse inwards towards the centre of the shaft, to compensate for the variation in the differential curves. When the blank has been received into the cup, the bar, I, is traversed in the reverse direction, to carry the blank up to the arbor of the mandril, O, where it is turned as in the original arrangement. This opposite movement of the bar, I, is effected by the onward movement of the crank, B, the pin of which next enters the second concentric curves, P, corresponding to those marked L. To allow time for the cutting action, the differential grooves are formed with another distinct curve, as at E, diametrically opposite to those marked N, and are, like them, made of a radius equal to the length of the rod, F, so that when the pin arrives at this portion of its travel, it communicates no movement to the bar, I, until it re-enters the part E.

The self-acting motion for the removal of the bobbin now comes into action. This motion is effected by the crank, Q, working the connecting rod, R, passing behind the headstocks to the back end of a double lever, the front end of which is jointed to a horizontal sliding bar, passed through the two standards of the fixed headstock as a guide, and bent up at a right angle, the end having an eye, S, fitting loosely to the mandril, immediately behind the bobbin. So soon as the bar, I, commences to travel outwards for a fresh blank, the sliding eye, S, actuated as described, pushes off the bobbin.

This machine is now working in Paisley, and effects a considerable saving beyond the best results of its predecessor. The "differential grooved disc and slotted crank movement" answers admirably for the compound uses to which it has been put, each of the movements being accurately timed for all the actions we have described. Its production is at the rate of 34 finished bobbins per minute, or about 140 gross per day of ten hours.

MINE MACHINERY.—R. White & J. H. Grant, Glasgow.—*Enrolled October* 11, 1850.

Messrs. White and Grant's invention relates, in all points except one, to arrangements for the prevention of accidents in the shafts of mines and similar situations, from the failure of the winding-rope or from "over-winding." The cage, or lifting apparatus, by which the miners and the minerals are raised to the surface, is fitted with two horizontal shafts, placed in bearings near the top, and in such manner that one shall come on each side of the cage guides. Each shaft has fixed upon it, at its longitudinal centre, a chain pulley, and chains from these pulleys pass upwards to the link connecting the cage to the chain. This link is passed loosely through an eye in the fixed suspension rods of the cage, and has a collar at its extremity, so that, when the cage is raised, the link slides a short distance through its eye, drawing up the two "safety chains" of the two pulleys, until the collar of the link comes to a bearing beneath its eye, and thus supports the weight of the cage. The same pulleys have one end of an elastic India rubber band passed partially round each, the band thus extending across from one pulley to the other, and the extreme ends of their shafts have each keyed upon them an eccentric pulley, serrated or notched on a portion of their periphery. When there is no strain upon the winding-rope, the elastic reaction of the India rubber band causes the set of four eccentric holding pulleys to bear upon the two timber cage guides, by turning the two shafts sufficiently round to bring the eccentric serrated portions of the pulleys against the guides. When the winding action commences, the tension, acting first of all upon the safety chains, eases off the pulleys from the guides, and thus the cage moves freely in the usual manner. Should, however, the rope be accidentally broken, the elastic band brings the four holding pulleys to bear upon the guides supporting the cage, until the rope is readjusted—the arrangement of the pulleys being such, that the greater the weight upon the cage, the more firmly will it be held up.

The patentees also show a contrivance of a similar nature for grasping the rope itself, in case it should fail at any point near or beyond the overhead winding pulley. For this end, the elasticity of a cushion of India rubber is most ingeniously taken advantage of. The bearings of the overhead winding pulley each rest upon an elastic cushion, so that when the winding-rope is in order, the tension upon it compresses the elastic material, and the sinking of the bearings releases the holding pulleys from the rope. If the rope breaks, the re-active elasticity brings the holding pulleys into action to sustain the cage. Another branch of the improvement refers to a detaching catch for disengaging the cage from the rope when in danger of being overwound; and a fourth point relates to the employment of elastic cushions to mitigate the concussions on the platforms of mine shafts. The last head has for its object an automatic contrivance for opening and closing the trap-doors in mine workings. The claims are in accordance with these heads of improvement, an illustrated description of which will be found in the *Practical Mechanic's Journal* for December next.

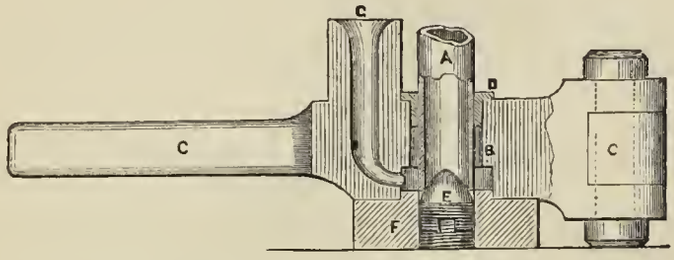
JUNCTIONS FOR GLASS PIPES.—W. Mayo, London. *Enrolled August* 21*st* 1850.

Mr. Mayo's plan for accomplishing the rather difficult operation of joining lengths of glass and earthenware pipes to each other, or to other objects, is to cast on the ends of the pieces to be so connected, metal flanges, to give effect to the holding power of the ordinary screw-couplings, which are thus adapted for the purpose. Our engraving, fig. 1, is a side elevation, with parts in section, of the mould he employs for casting on these ends; the end of a pipe being shown *in situ*, ready for the operation. Fig. 2 is a corresponding plan of the mould, and fig. 3 is an

elevation of a finished junction as holding together two pipes, the screw couplings being in section.

A Is the end of a glass or earthenware pipe, as placed in the mould to receive its metal flange, the form of which is represented by the recess,

Fig. 1.



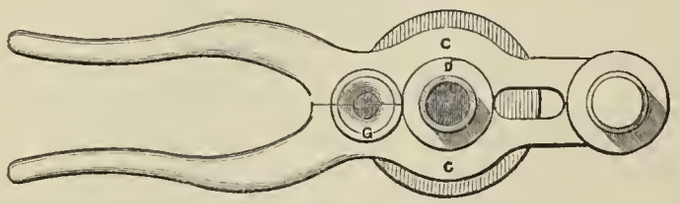
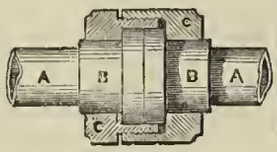


Fig. 2

B, in the mould. The latter is made on the principle of the common bullet mould, in two parts, c c, hinged together to allow of the entrance and exit of the pipe, which is held accurately in a vertical position during casting, by the collar D. A conical plug, E, is screwed into the bottom plate, F, so that the point of the cone enters the open end of the pipe as a further guide, its shape allowing it to answer for various bores of pipes. The metal employed is pure tin, which is poured in by the "get" or channel, G; the pipe, A, being first warmed to prevent accidents from the sudden action of the heat of the fluid metal.

Fig 3.



It is a curious fact, that the flanges cast on glass or earthenware pipes in this way, have a most secure hold upon the surface of the latter; and the connections so formed are generally quite tight, so as to resist a very considerable fluid pressure.

The detail, fig. 3, shows the form of flange which would be produced by the section of mould shown at B, in fig. 1. A A, Are the two ends of separate pipes, with the flanges, B B, as cast on them, and a little cement, as bees' wax, being spread on the end faces of the pipes and flanges, these are brought together and held by the screw couplings, C C. Various sections of moulds may obviously be used, according to the peculiar object to be produced; and by this means, flanges, tubes, and connections of various kinds, may be cast on glass vessels, for attaching tubes or covers thereto.

The patentee claims the forming of connections or joints on glass pipes, and connecting such pipes with other matters, by making castings of metal on glass pipes.

REVIEWS OF NEW BOOKS.

Review of the Report of the General Board of Health, on the Supply of Water to the Metropolis. By Samuel Collett Homersham, C.E. Pp. 72. London: Weale. 1850.

Mr. Homersham has earned for himself some considerable credit for his energy on behalf of a good water supply for London; and the *Practical Mechanic's Journal* has more than once borne testimony to his untiring efforts in this important matter. This "Review" has arisen entirely from the peculiar stand taken by the Government Board of Health, in reference to the much-vexed question of where, and how, London can be best supplied with pure water, and is contained in a Report to the Directors of the London (Watford) Spring Water Company.

It appears that, since the appearance of Mr. Homersham's former report to the directors of this company, a bill, supported by a petition signed by no fewer than 39,000 of the inhabitants of the district, from Watford on one side, right through Westminster to Chelsea on the other, was formally presented to the House of Commons, but rejected in order to give time for the legislature to consider upon the Report of the General Board of Health. This long-expected report has now appeared, but without any credentials in the shape of the documentary or other evidence upon which it professes to be founded It professes also to be devoted to the consideration of "the water supply of the metropolis;" but, according to Mr. Homersham, it is by no means confined to this question—is "devoid of clearness and order," and "inexplicit and confused on matters of vital importance"—and lastly, the greatest sin in the eyes of Mr. Homersham, it proposes "a counter project for erecting new water-works for the supply of the whole metropolis, and for buying up the old ones." For his arguments on behalf of the pure and cheap water of the Watford Company, against what certainly appears an impracticable plan of the Board of Health, we must refer inquirers to the work itself; extracting, meanwhile, some useful notes on the terms *Hard* and *Soft* water:—

"The popular expressions *hard* and *soft* water really give little information concerning the wholesomeness or character of a particular water, and its adaptation for drinking or culinary or even washing purposes. Water may be 'soft,' free from organic impurity, but, owing to the presence of a large quantity of mineral matter, be quite unfitted for drinking, cooking, or even for washing. To give a practical illustration: the water supplying the Trafalgar Square fountains, and which is lifted from a well sunk into the chalk formation beneath the London clay, the bottom of which is about 350 feet below the level of the sea, is a 'soft' water about 5½° of hardness; but this water contains, according to the analysis of Mr. Brande and the Royal College of Chemistry, from 66 to 79 grains of mineral matter per gallon, from 60 to 72 grains of which are common salt and soda. Water of this description is unfitted for drinking or making tea, and some other culinary operations, because the soda contained in it, when habitually used, acts medicinally on the kidneys; and it is unfitted for washing, because the effect of soda, if used for washing clothes, tends to discolour white cotton, flannel, or linen, and to spoil the colours of certain prints; it is also unfitted for warm baths, because the soda is apt to form a soap with the oily matter which exudes from the pores of the skin, and therefore causes it to become rough and chap.

"On the other hand, water may be 'soft' from the almost entire absence of mineral matter in solution; water of this description, from only 1 to 2 degrees of hardness, may be found in streams fed from the rain falling upon the primitive geological formations. I have had water analyzed that was collected from streams fed by the rain falling upon the millstone grit formation containing only 2½ grains of mineral matter per gallon, and only $1\frac{1}{10}$th degree of hardness, and yet the use of this water for most purposes is avoided by the inhabitants living near these streams, because a large portion of the ground draining into them is covered with peat, which, being taken into solution, and especially in summer weather, so completely contaminates the water with organic matter, that it is unfitted for drinking; for, when so used, it produces sickness and diarrhœa. These streams, especially after heavy rains in the summer time, are discoloured with peat, and if used for washing, stain the coarsest linen and dim the bright colours of printed goods. This water is also bad for making tea, and spring water of a somewhat *harder* character (about 4 degrees of hardness) is used in preference for this purpose; because, as the inhabitants express it, such very soft water draws out the leaf of the tea, and spoils the flavour.

"It may be noted that M. Soyer states as the result of his experiment upon tea-making, that 'the softest or distilled water had an extraordinary power in obtaining a quick extract; *the result showed perhaps too high a power, for it draws out the woody flavour.*' It is some years since my attention was first practically drawn to the fact that water might be too soft for the making of tea, and M. Soyer's evidence accords with popular experience in this respect.

"It may not be out of place to mention here that carbonate of soda, when added to a solution of tea, deepens the colour of the tea, without either improving the flavour or the strength; any one may prove this by pouring out a cup of tea and separating it from the grouts; if a small quantity of carbonate of soda be added to such a solution, the colour will be sensibly deepened, although it is quite evident that the strength of the tea is no greater after the addition of the soda than before. This fact may account for M. Soyer stating, that the water procured from the deep well of the Reform Club and Trafalgar Square fountains (both of which waters contain a quantity of carbonate of soda) ranks number one for tea-making; M. Soyer being doubtless misled by the *colour* of the infusion. His taste, being habituated to a water containing soda, would not be offended by the taste of this alkali.

"As we see, then, water may be 'soft' and free from organic matter, and yet, from the presence of a large quantity of alkaline salts, be unfitted for nearly all domestic uses. Water may also be 'soft' from the almost entire absence of salts, and yet from its high extractive power be unfitted for tea-making; while such water, especially in summer, when collected from the drainage of land covered with peat, or even vegetation of any kind, takes greedily in solution organic matter, which renders it unwholesome for drinking, and when discoloured with peat, quite unfitted for washing purposes.

"It is only when 'soft' water is free from alkaline salts, and devoid of organic matter in solution, that it can be considered as fitted for domestic purposes. Spring water issuing from the millstone grit, and other primitive formations, is often of this character; but the soft surface water collected in reservoirs, and used to supply Preston, Bury, Ashton, and other towns in Lancashire, is not good drinking water, owing to its containing, in the summer, organic matter; and it is a pity, that when Dr. Sutherland was directed to make his 'local investigations' in Scotland and Lancashire, he was not instructed to inquire particularly into the amount of organic matter contained during autumn and summer weather in the 'soft' water collected in reservoirs for the use of town populations; had he done so, he would have discovered, what is well known to all practically acquainted with the subject, that the great bulk of such waters, at these seasons, are impregnated with organic impurities.

"The term *hard* water is equally indefinite as *soft* water. 'Hard' water may be 'hard' from holding in solution (as explained in the body of the Report) a certain amount of either lime salts or magnesian salts; and the character of a lime salt or magnesian salt again varies according as it may be combined with carbonic acid on the one hand, sulphuric acid, nitric acid, or any other acid, on the other hand. The quality and adaptation of a 'hard' water for domestic purposes is very different, according as it may be 'hard' from the presence of magnesia or lime, or of both these salts; so that it is only by knowing the amount and character of the mineral matter from which a water derives its 'hardness' that its wholesomeness or unwholesomeness, and its adaptation for domestic purposes, can be predicted.

"Again: 'hard' water may be contaminated, especially when warm, with excremental or organic matter in solution, although it is not so readily poisoned with these impurities 'soft' water when free from alkaline salts."

Report of the Commissioner of Patents, to the Senate of the United States, on the Subject of Steam Boiler Explosions. 8vo. Pp. 184. Plates

In the year 1848, the Senate of the United States directed the Commissioner of Patents to report "such information as he may have in his possession, or may obtain, that he deems important, with reference to

further legislation by Congress, for the prevention of the explosion of steam boilers used in boats, or for engines on railroads, and whether any amendment to the patent laws are advisable in effecting such object;" and the Report before us, is a reply to the resolution. As might be expected, it exhibits a melancholy list of casualties, obtained in as complete a manner as could be expected, by addressing circulars to the whole of the collectors at the ports of the United States. The returns thus received, enumerate 233 steam-boat boiler explosions, the aggregate number of deaths resulting from 164 of which, are stated at 1,805. In the other cases, the deaths are not given. In 111 cases, the wounded are given as 1,015. For the "causes of explosions," the Commissioner refers to the labours of the Committee of the Franklin Institute in 1831, who laid down the four heads of—excessive pressure, gradually increased, undue heating of the metal of the boiler, defective construction, and carelessness. Upon these points the author dwells to a lengthened extent, and analyzes the accidents with considerable succinctness. He also furnishes a very full statement of the various contrivances proposed for the prevention of these fatalities. This portion of the volume contains some excellent information, and we must return to it as occasion offers.

With reference to the second portion of the inquiry, the commissioner states that he "has no hesitation in expressing his belief that no modifications of the patent laws would have any tendency to lessen the evils which it is the object of the proposed legislation to investigate," and recommends that "the best remedy for all the evils complained of, would be to make a strong appeal to the interests of boat masters and proprietors, by giving a remedy, where explosions result in injury to persons or property, to the individuals wounded, or to the nearest relative or friend of the killed, in the shape of heavy damages recoverable by action at law." Some good illustrative plates adorn the work, which deserves the careful perusal of the practical engineer.

ON STEAM BOILER EXPLOSIONS, AND SOME NEWLY-DISCOVERED PROPERTIES OF HEAT.

I.

The history of the steam engine shows, that Watt found it a very inefficient engine, the duty of the best before his improvement not exceeding seven and a half million pounds for each bushel of coals expended, while he improved it until the duty reached twenty-seven million pounds, when he was satisfied it had attained perfection.

Now it may be safely asserted, that in no marine engine has this duty been exceeded, for it is much more probable, that duty has seldom or never been reached in marine engines, because the best are but imperfect copies of Watt's, wherein a most essential part of his improvements has been neglected and omitted from general ignorance of its utility; meanwhile the Cornish engines have been so steadily and generally improved, that the duty of a number thereof averages from sixty to seventy millions pounds. Some have reached one hundred millions, and one reached one hundred and twenty millions.

Though it is a very important matter that ores should be extracted from mines at the cheapest rates, yet it seems to be more important that the duty of all engines, particularly of marine engines, should be improved if possible to as great or greater degree, seeing that not only is an immense weight of costly fuel wasted, and of troublesome and expensive labour for the useless destruction thereof, but such an enormous proportion of valuable tonnage is now uselessly occupied for coals, that steamers for only voyages to Europe are so loaded therewith, as to have but little comparative space for profitable freight.

It would have been reasonable to expect that the London engineers, who were so extensively engaged in constructing ocean steamers, would have gladly introduced, and, if possible, exceeded the Cornish improvements. Instead of which, in the first volume of the Transactions of Civil Engineers, they print a paper of Mr. Palmer's, not only for denying, but for showing that it was impossible (by the unerring laws of nature, kindly manufactured for nature by Mr. Palmer,) by any contrivance of human wisdom, to obtain more than forty-five million pounds' duty from a bushel of coals; and the engineers of Manchester, Birmingham, and London, would never credit the performance of the Cornish engines, till one was proved in London.

A year hardly elapsed ere a Cornish engine, erected at the East London water-works, performed the duty of more than ninety millions pounds. Still Dr. Lardner, who praises Watt's performances as superhuman, awards no praise to the Cornish engineers, who have so immeasurably surpassed Watt, but, on the contrary, endeavours to award all the praise to Watt, by stating the Cornish engineers have discovered no new principle; a ridiculous statement, proving nothing but the Dr.'s profound ignorance of the means employed to realise the great achievement, and which a late writer in one of the English periodicals has asserted is of such great value, that whoever could introduce the same improvement to the marine engine, would deserve not only the largest fortune and the general thanks of mankind, but the gratitude of the latest posterity.

As our endeavours can be better directed hereafter to show the means by which the great improvement of the Cornish engine has been effected, and as this part of our work will necessarily require many and long details, and will therefore occupy much space and time, we will at present postpone that part of the subject, and proceed to publish, for the first time, in detail, a new and chemically distinct and better method of obtaining a vastly greater effect from the same amount of fire and water than can be obtained directly by steam; and which new and direct force being also as capable of mechanical increase by mechanical expansion as steam, it may in all possible cases be caused to exceed steam immensely in value and economy. But we will, in the first instance, describe in what manner the discovery of this new force was made.

Lord Brougham, in his admirable discourse on the "Objects, Pleasures, and Advantages of Science," observes, that "practical men are always in the way of good luck, by perceiving what is wanted or amiss in the old methods, and therefore they have a better chance than others of effecting improvements, and if they possess the requisite information, they can take advantage of it when it comes to them."

Having many years ago had particular "good luck," by narrowly avoiding the explosion of a steam boiler, by a singular and happy thought and different action to that commonly pursued and recommended, and as it may prove beneficial to others similarly situated, as well as instructive to the general reader, and as it was the commencement of the great discovery hereafter disclosed, I shall detail the occurrence.

Whilst superintending the working of a high pressure and condensing engine of considerable power, I was suddenly alarmed by intelligence that the water was become deficient in the boilers. Now long before that period, by carefully observing the numerous accounts of disastrous explosions of steam boilers, I had formed an opinion, that on such occasions it was dangerous to suddenly open the safety valves to discharge the steam, and which in this instance it was requisite to do, before the interrupted proper action of the feed-pump could be restored.

The first thing I did was to stop the engine; the second, to slightly increase the load on the safety valves; the third, to draw the fires and leave the cylindrical boilers buried in brickwork, to be cooled by the rapid current of air rushing past them up the chimney, for more than an hour. At the expiration of that period, as there was still considerable though apparently weak steam escaping, though almost noiselessly, from the safety valves, and which steam I even then dreaded to discharge, although at that time I could have given no very satisfactory reason for my apprehensions, I passed a rope over a pulley, and fastening one end of it to the lever of the safety valve, I led the other end to a distant and strong building, and then pulling the rope, opened the safety valve thereby.

The steam which had appeared weak, and escaping with scarcely any noise, suddenly rushed out with such a tremendous noise and volume, as satisfied me at the time, that it had somehow suddenly acquired some new property and great power for mischief, so that I had no doubt, had the safety valve been opened somewhat sooner, the boilers, though of extraordinary strength, would have been blown to pieces.

The affair made so strong an impression on my mind, that I have never since failed to pay particular attention to every description of facts which I have since seen recorded of explosions, anxiously endeavouring to account therefor in a rational and satisfactory manner.

Having some time since had my attention again very strongly attracted to the details connected with the explosion of a large steam boiler, on which occasion also it was apparent, as it had frequently been before observed, that some immense explosive force had been suddenly generated, and never before accounted for in a satisfactory manner, I set myself earnestly at work to investigate experimentally the causes of those terrible disasters, at once the opprobrium of engineers and a calamity to mankind, to discover, if possible, that long suspected, but still unknown and undetected sufficient cause therefor.

This important subject had already strongly attracted the attention of numerous engineers and of other persons in various countries, and it is curious to see what insufficient and contradictory results they arrived at, all incompatible with many well known facts that had been noted—particularly with two, which had been very often remarked:—

First: It had been often remarked that previous to an explosion the engine had laboured much, and become insufficient for its usual duty, and which fact is perfectly at variance with the most commonly assumed position, that the explosions arise from over-increased tension of steam in boilers, for in that case the engines must have become more, instead of less powerful.

Secondly: Explosions of boilers are of frequent occurrence when it is morally certain the steam therein had just previously been of greater tension, and at the instant of lowered tension, as when steam had become unduly high by the stoppage of the boat at a wharf for a short period, when an explosion seldom or never occurs, nor till the engine has made "several strokes," or till the vessel has got to "some distance from the wharf,' when the explosion ensues, and of course under a diminished head of steam, or reduced tension, to what it had previously been.

Notwithstanding the inadequate result of numerous investigations, long and earnestly prosecuted at great expense, it will seem passing strange that they were all so unsuccessful, seeing so little was needed in prosecuting a most happy and singular conclusion which we have since arrived at by a certain, short, and easy path. It is truly wonderful to see how nearly many experimenters have approached, without at all reaching, the object they were in search of.

Thus, for one instance of a tedious, expensive, and perfectly abortive attempt, Perkins having conceived an idea, that "surcharged steam," as he termed it, might be produced in overheated boilers, become powerful and produce explosions. To test the same he constructed a cumbersome and expensive apparatus, or generator, consisting of three tiers of cast-iron hollow blocks, set in a large mass of brickwork, the blocks being so connected together by slight wrought-iron tubes, that water might be forced into the two upper tiers, and, as he said, heated therein to between 700 and 800 degrees, and be forced from thence into the third tier, into which, as he stated and expected, "the heated water would flash into steam," and that steam becoming "surcharged with heat" in the lower tier, would be found to have acquired immense force from being surcharged with heat. Nevertheless, to his great surprise, and directly contrary to his anticipations, he found the steam to be very feeble, possessing but little of the tension he anticipated, for he had expected thus to have produced steam of exceeding great strength.

Now it is neither difficult to explain or to account for his great disappointment on this point. In the first place he never could have confined water at the temperature of 750° in his cast-iron blocks, because at that temperature cast-iron has little tenacity, and the tension of steam therein would have equalled a thousand atmospheres per inch, and his blocks could not have sustained a sixth part of that great internal pressure. Moreover, as the wrought-iron connecting tubes were little stronger than common gas tubes, it was idle to suppose they could sustain one-tenth the strain they would be subjected to. In the second place he reckoned upon another impossibility, namely, that water heated to 750° would flash into steam, seeing that the latent heat in steam being about 1170°, the third tier of his blocks would furnish only the remaining requisite heat for the conversion of the water (were it already heated to 750°, which it could never have been) into common weak steam, which he found it to be.

Perkins then took another and as unfortunate a view of this subject. Still imagining his steam was surcharged with heat, (which it could not have been,) he conceived that it was deficient in tension because, being surcharged with heat, it was deficient of water; he, therefore, undertook to obtain pure steam of immense tension by injecting his "surcharged steam" through many small holes in a pipe, placed under water within a strong reservoir constructed for that purpose, wherein, he asserted, his surcharged steam took up its equivalent of water, and became thereby immensely powerful and economical also; although by this clumsy roundabout process for forming common steam, it must be seen he neither did nor could derive any possible advantage, as was clearly shown on examination thereof in the truly scientific attempt to discover the real cause of the explosions of steam boilers, by the employment of rational means for that purpose, by a select committee of the Franklin Institute of Philadelphia.

For in 1835, this subject being considered of such great importance by the government of the United States, that at its request and expense it was long and ardently investigated by the select committee at Philadelphia, by which all the most plausible theories that had been previously promulgated by Perkins and others, were patiently and experimentally investigated, and all alike found to be unsubstantiated, or contradicted by facts. After examining other matters connected with the subject and deserving investigation, the indefatigable committee arrived at the conclusion, that explosion of steam boilers occurred from the tension of steam becoming gradually superior to the strength of the boiler; and the prevention they mainly proposed therefor was the use of double safety valves and of fusible metallic substitutes for valves, so chemically compounded, as to give way before great tension of steam could occur in the gradual manner they anticipated.

The extended mechanical and scientific proceedings of this committee, removing many errors, establishing many facts by valuable experiments and information, are ably set forth in consecutive numbers of the *Franklin Journal*, commencing in January, 1836, terminating June, 1837; the latter portion being devoted to a valuable and useful investigation of the strength of the materials of steam boilers at various temperatures. To some of their investigations we shall hereafter profitably revert. That many explosions have occurred solely from the tension of the steam becoming greater than the boiler could sustain, and will again occur from the same cause, more certainly as boilers become older and weaker, was too obvious to have required a scientific investigation; but as all such explosions must have occurred when the steam had acquired its greatest strength, it is apparent some other more occult cause must exist, because many of the most frequent and dreadful explosions have happened, when it was morally certain the steam had considerably less tension than the boilers had just previously sustained. Moreover, just as violent and destructive explosions have taken place in low-pressure boilers, in which the steam at any time could have had but little tension. Notwithstanding this, both high and low pressure boilers have occasionally exploded by a suddenly-generated force, that could be likened only to that derived from the instantaneous explosion of gunpowder.

Still, at later periods, the world has been bewildered with attempts, vainly and inadequately, to explain the mysterious cause of explosions. Nothing can be more injurious to science than the adoption of whimsical and inadequate theories; and it must be remarked, that none have been more whimsical, or unfounded, or pertinaciously persisted in, than those of the learned author of seven editions of a treatise on the steam engine, and in which treatise another, a greater, a more ridiculous and more mischievous error, still remains to be exposed on the fitting opportunity.

Because the explosion of a locomotive steam boiler and a tempest occurred on the same day in Pennsylvania, Doctor Lardner attempted to prove, in his learned manner, that the explosions of steam boilers were occasioned by lightning!

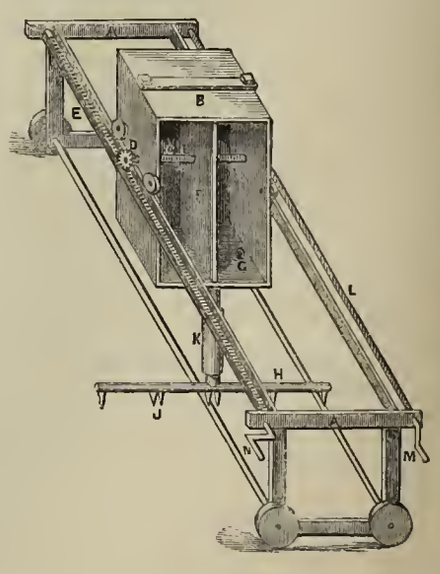
Unfortunately for the doctor's profound knowledge of steam, it subsequently appeared, the tempest had ceased for some hours before the explosion occurred; and still more unfortunate for his electrical knowledge, no situation can be conceived more free, or so free, from the effects of lightning than the interior of the metallic boiler of a locomotive in metallic connection with a railroad.

The curious fact and the cause thereof will soon become apparent, however singular it may now appear, that under particular circumstances, by no means unfrequent, the sudden abstraction of a volume of steam from a boiler may become the inciting cause of the explosion of that boiler, however strong. How needful, then, must be a knowledge of this hitherto unsuspected cause of such disasters, even were this knowledge unaccompanied by any other advantage! and more especially because, in this particular case, the very means that have been prescribed by the best authorities as the means of prevention, become the sure means of destruction.

Brooklyn, New York. JAMES FROST.

WINDOW-SASH PUTTYING MACHINE.

The accompanying sketch represents a machine which I have invented for puttying the sashes of windows, and if you think it of sufficient moment, I shall be glad to see it in your *Journal*. It owes its origin to the "Great Exhibition," for it was designed for the purpose of puttying the sashes for the vast ranges of windows of the "palace of glass." Referring to the sketch



—A, is a rectangular timber frame, carrying the cylinder, B, containing the putty. A screw, C, is passed horizontally through the cylinder, the spindle having upon its end a pinion, D, so that when the cylinder is made to traverse along the frame, the action of the rack, E, causes the screw to revolve. F, Is a piston fitted to the cylinder, and having a nut in its centre, through which the screw, C, passes; so that, as the latter revolves, the piston is made to traverse, and the contained putty, being compressed by it, is forced out by the bottom of the aperture, G, into the tubes, H, finally exuding through suitable apertures. At J, are small knives for spreading and smoothing the putty, as it is forced out from the tubes;

and a nut is placed at K, upon the main conducting tube, to admit of the adjustment, up or down, of the discharge orifices.

The traverse motion of the cylinder back and forward on the framing, is obtained from the horizontal screw, L, turned by the winch-handle, M; and to avoid giving the piston a retrograde movement on the return traverse of the cylinder, the rack, E, is turned over out of gear with the driving pinion by the handle, N. The putty is put in at the top of the cylinder, the lid being held down by a cross-bar and screws. Of course, this modification of the machine is intended only for puttying sashes on the tops of buildings; but it is pretty obvious, that it may be so made as to answer for vertical sashes, or it may be used as a fixture, the piston being driven by steam power, whilst the sashes are traversed beneath it; but its general features cannot, I think, be simplified.

W. J. Warner.

London, October, 1850.

THE BRITISH ASSOCIATION AND RUTHVEN'S STEAM-SHIP PROPELLER.

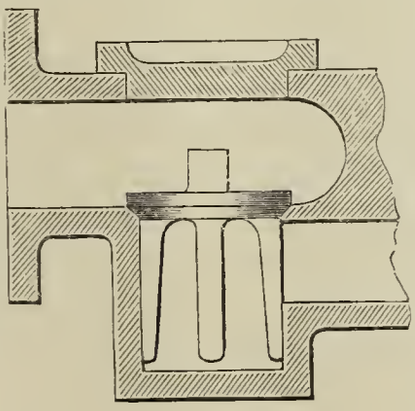
There are a few typographical errors in this article, given at page 165 of your last issue, which I shall feel obliged by your correcting. They are as under—

1st col. p. 165, line 8—for *viz.*, read *nay.*
" " 5th line from the end of first paragraph—for *cymbals*, read *symbols.**
" " 21st line from bottom—for (B), read (*h*).
2nd col. " 3rd and 10th lines—for *o*, read 0 (numeral).
" " 22nd line—for *as*, read *on.*

D. K. C.

HUMPHREY'S IMPROVED PUMP-VALVE.

The annexed sketch is a vertical section of a new form of pump-valve, which I should be glad to see in the *Practical Mechanic's Journal*. The object of the contrivance is to obtain a clear water-way when the valve rises, and yet retain the simplicity of the old three-fourth valve. To accomplish this, I make the valve with three legs set round the circumference, in place of the feathers. The sketch, I think, shows the advantages to be secured by this simple modification. In large valves, the lightness will be an evident improvement.



J. D. Humpherys.

London, October, 1850.

POWER REQUIRED TO WORK STEAM-ENGINE AIR-PUMPS.

I should be glad to know what power is necessary to work the air-pump of a low-pressure engine,—say one of twenty horses' power. As authorities give different calculations, perhaps some of your mechanical correspondents can inform me what amount of power is really expended in this way.

K.

October, 1850.

SKETCHING APPARATUS—THE PENTAGRAPHIC DELINEATOR.

In a recent number of the *Practical Mechanic's Journal*, is a query as to what is the best description of instrument for assisting amateurs in sketching. May I, therefore, refer "A Sketcher," or others who may be interested in the subject, to my "Pentagraphic Delineator," figured and described at page 230 of your first volume. As the cost is a point mentioned by your correspondent, I have to state that the instrument may be had complete for from 18s. to 32s.

James Robertson.

Ardrossan, October, 1850.

* [We regret that this little tinkling pun should have been inadvertently choked by an unpurning printer. Probably he thought—and we are not quite sure whether or not we should disagree with him—that puns and mathematics are best separate. For the remaining errata, we tender our humble apologies, coupled with a recommendation to our correspondent, to trust less to hieroglyphics, and more to round-hand.—Ed. P. M Journal.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—TWENTIETH MEETING.—Edinburgh, August 1, 1850.

"On the Incrustation which forms in the Boilers of Steam-Engines," in a letter addressed to Dr. G. Wilson, F.R.S.E., by Dr. J. Davy.—On entering on this inquiry, which I did after my return from the West Indies in December, 1848, and after communicating a short paper to the Royal Society, "On Carbonate of Lime in Sea-water," it appeared to me desirable to collect as many specimens as possible of incrustation from the boilers of steam-vessels, now so widely employed in home and distant navigation. By application to companies and to friends in our seaports, as Dundee, Hull, Southampton, Hayle, Liverpool, Whitehaven, I have succeeded in procuring specimens of incrustation formed by deposition in voyages from port to port, in the British and Irish Channels and the North Sea, between Southampton and Gibraltar, in the Mediterranean and the Black Sea, and in the Atlantic Ocean, between Liverpool and North America, and between Southampton and the West Indies. I am promised specimens from the Red Sea and the Indian Ocean,—but these I have not yet received. The character and composition of the incrustation, whether formed from deposition from water of narrow seas or of the ocean, I have found very similar; with few exceptions, crystalline in structure, and, without any exception, composed chiefly of sulphate of lime; so much so, indeed, that unless chemically viewed, the other ingredients may be held to be of little moment, rarely amounting to 5 per cent. of the whole. From two specimens of incrustation from the boilers of steamers crossing the Atlantic, one of which you sent me, in which you had detected a notable portion of fluorine, judging from its etching effect on glass—I also procured it; it was in combination with silica: and procured it also so combined from two obtained from steamers navigating our own seas, one between Dundee and London, the other between Whitehaven and Liverpool. Of this I had proof, by covering with a portion of glass, or platina foil, a leaden vessel charged with about 200 grains of the incrustation mixed with sulphuric acid, and by keeping the glass cool by evaporation of water from its surface, and by supplying moisture for the condensation of the silicated gas by a wet band round the mouth of the vessel. After about twenty-four hours under this process, a slight but distinct deposition was found to have taken place, corresponding to the margin of the vessel,—a deposition such as that produced by silicated fluoric acid gas under the same circumstances. Thus it was not dissipated by heat nor dissolved by water, and yet admitted of removal by abrasion, either entirely or in great part,—the former in the instance of platina foil, the latter in that of the glass. Besides the ingredients above mentioned, I may add that, in many instances, oxide of iron, the black magnetic oxide, was found to form a part of this incrusting deposit, collected in one or more thin layers; and further, that in some, especially of steamers navigating the narrower and least clear part of the British Channel, the depositions presented a brownish discoloration, produced by the admixture of a small quantity of muddy sediment. Incrustations so discoloured, I may remark, are reported to be most difficult to detach. I have said that the incrustations, with few exceptions, were similar in their structure, and that that was crystalline,—it was not unlike the fibrous variety of gypsum of the mineralogists. The specimens received, as might have been expected, varied very much in thickness, viz., from one line and less to half an inch. I have endeavoured, by a set of queries which I had distributed, to obtain information respecting the exact time in which the incrustations were formed, and under what circumstances; but with partial success only, owing, it may be inferred, to a want of exact observation. In one instance, that of the North American mail-ship Europa, which arrived at Liverpool on the 15th of November, at 4 p.m., having left Boston on the 7th of the same month at 9 a.m., an incrustation was found in her boiler of about one-fiftieth of an inch in thickness; and it is stated that an incrustation of about the same thickness was found on her outward voyage. This example may aid in giving some idea of the degree of rapidity with which the incrustation is produced, at least in the Atlantic, with the precaution of "blowing off" every three hours, and with the "brine pumps" kept in constant work. In other seas, especially contiguous to shores, and more especially of shores formed by volcanic eruptions, it is probable, *cæteris paribus*, the rate of the deposition of the incrusting sulphate of lime will be more rapid. The results of the trials of several portions of sea-water taken up on the voyage from the West Indies to England, noticed in the paper of mine already referred to, are in favour of this conclusion. To endeavour to prevent the deposition of the incrusting matter or to mitigate the evil, various methods, it would appear, have been had recourse to—some of a chemical kind, as the addition of muriate of ammonia and sulphate of ammonia to the water in the boiler—without success, as might be expected; others, of a mechanical kind, with partial success,—as the introduction of a certain quantity of sawdust into the boiler, or the application of tallow, or of a mixture of tallow and plumbago to its inside, to prevent close adhesion, and the more easy separation of the incrusting matter, either by percussion, using a chisel-like hammer, or by contraction and unequal expansion, by means of flame kindled with oakum, after emptying the boiler and drying it. Of all the methods hitherto used, that of

"blowing off,"—that is, the discharging by an inferior stop-cock a certain quantity of the concentrated water of the boiler by the pressure of steam, after the admission above of an equivalent quantity of sea-water of ordinary density, appears to be, from the reports made, the most easy in practice, the least unsuccessful, and the most to be relied on. But, as in the instance given of the North American steamer, it can be viewed only as a palliation. Considering the composition of the incrusting matter and the properties of its principal ingredient—the sulphate of lime, a compound soluble in water and in sea-water, and deposited only when the water containing it is concentrated to a certain degree—there appears to be no difficulty, theoretically, in naming a preventive. The certain preventive would be the substitution of distilled or rain water in the boiler for sea-water. Of this we have proof in the efficacy of Hall's condenser, which returns the water used as steam, condensed, after having been so used; but, unfortunately for its practical success, the apparatus is described as being too complicated and expensive for common adoption. Further proof is afforded in the fact, that the boilers of steamers navigating lakes and rivers, in the waters of which there is little or no sulphate of lime, month after month in continued use, remain free from incrustation. This I am assured is the case with the steamers that have been plying several summers successively on the lake of Windermere. And it may be inferred, that in sea-going steamers in which sea-water is used in the boiler—or, indeed, any water containing sulphate of lime—the prevention of deposition may be effected with no less certainty, by keeping the water at that degree of dilution at which the sulphate of lime is not separated from the water in which it is dissolved. From the few trials I have made, I may remark, that sulphate of lime appears to be hardly less soluble, if at all less, in water saturated with common salt, than in perfectly fresh water. This seems to be a fortunate circumstance in relation to the inquiry as to the means of prevention, and likely to simplify the problem. If these principles be sound, their application under different circumstances, with knowledge and judgment on the part of the directing engineer, will probably not be difficult. His great object will be, in sea-going steamers, to economize the escape of water in the form of steam, and thereby also economize heat and fuel; also, when fresh water is available to use it as much as possible; and further, to avoid using sea-water as much as possible near coasts, and in parts of seas where sulphate of lime is most abundant. From the incrustation on the boilers of sea-going steamers, the attention can hardly fail to be directed to that which often forms, to their no small detriment, in the boilers of locomotive railway engines, and of engines employed in mines, and in the multifarious works to which steam power is now applied. These incrustations will of necessity be very variable, both in quantity and quality, according to the kind of ingredients held in solution in the water used for generating the steam. Hitherto I have examined two specimens only of incrustations taken from the boilers of locomotive engines, and a single one only from the boiler of a steam-engine employed on a mine—a mine in the west of Cornwall. The latter was fibrous, about half an inch thick, and consisted chiefly of sulphate of lime, with a little silica and peroxide of iron, and a trace of fluorine. The former were from one-tenth of an inch in thickness to one inch. They were laminated, of a grey colour, and had much the appearance of volcanic tufa; they consisted principally of carbonate and sulphate of lime, with a little magnesia, protoxide of iron, silica, and carbonaceous matter—the last two, the silica and carbonaceous matter, probably chiefly derived from the smoke of the engine and the dust in the air. From the engineer's report, it would appear that the thinnest—the incrustation of about one-tenth of an inch—had formed in about a week, during which time the locomotive had run about 436 miles, and consumed about 10,900 gallons of water.

Mr. Scott Russell read a report from Rio Janeiro, which narrated the progress that had been made in the Brazils, within the last six years, in the application of the principles of the Wave System to the practical construction of ships, both of steam vessels and of sailing vessels. Mr. Butler Dodgson is a naval architect, employed in the Parta de Aria Iron Works and Dockyard, an establishment largely engaged for government in the construction of ships and steam vessels. He had early read the reports of the British Association, which contained an account of the wave system, and had been enabled to construct a number of vessels upon that system, and the present communication showed that he had done so with perfect success. The vessels built on this principle possess not only greater speed than others, but also every other good quality as sea-going vessels. Mr. Butler Dodgson encountered the usual opposition from the interests of rivals, and the prejudices of men in office; but, having tested and established the value of the principle, he is now employed to build large steamers for the government on that principle.—Dr. Robinson expressed his regret, that the knowledge of which foreign governments were thus enabled to avail themselves, was not turned to practical account by government at home. The British Association had made application to the government of this country to render the researches of Mr. Scott Russell, which had been carried on under the auspices of the Association, available to the public service; but hitherto without success.—A discussion arose regarding the recent applications of the wave principle to the construction of sailing-yacht schooners in England. The Titania had proved herself to be the fastest yacht of her size, and to possess in a high degree the qualities of a sea-going vessel, and she was built on the wave principle.

"On an Improved Gas Stove," by W. Sykes Ward, Esq., Leeds.

A plate of thin sheet-iron is fitted into an ordinary fire-place, in the manner of a fire-board, about two inches within the projection of the mantelpiece· about three inches in front of the back plate, a similar plate of sheet-iron is secured by bolts; a third—somewhat smaller—plate of iron is placed about one inch from the second plate, and enclosed at the top, bottom, and sides, so as to form a chamber of about two or three feet square, and one inch in thickness Towards the bottom of the last plate, a long aperture is cut, closed by a sliding plate acting as a door, for lighting the gas jets, and admitting a small quantity of air. A little below the aperture a pipe is introduced, in which is fixed three or more gas jets, either the ordinary small bat-wing burners, or tips, with two or three holes, so that the flame may extend laterally, not coming into immediate contact with the iron. From the top of the enclosed chamber, a pipe an inch and a half in diameter proceeds through the second and first plates into the chimney of the room.

The author found that this apparatus was sufficient to raise the temperature of a moderate-sized apartment from five to ten degrees Fahr., with a consumption of about three feet of gas per hour, costing about twopence for ten hours; and that it was particularly useful in warming a bed-room, where only a slight elevation of temperature was required, and perfectly free from the production of dirt, or the slightest smell. None of the products of combustion entered the room, and the ventilation was improved rather than impeded.

The novelty consists in constructing the stove in a vertical position, so as to expose a considerable surface for the absorption of heat from gas burners, and for the radiation of the heat; that, from the flatness of construction, the apparatus occupies little space, not projecting into the room more than two or three inches, being thus productive of little inconvenience when out of use.

"On the limits to the Velocity of Revolving Lighthouse Apparatus, occasioned by the time required for the production of luminous impressions on the eye," by William Swan, F.R.S.E., teacher of mathematics, Edinburgh.

Lighthouse apparatus is either fixed or revolving. A fixed light distributes its rays uniformly over the horizon, while a revolving light concentrates them on a few points, so as to leave the greater part of the horizon at any instant in darkness; and the revolving motion is communicated to it, in order that its rays may visit every portion of the horizon in succession. It follows from this, that the flash of a revolving light is brighter than the constant gleam of a fixed one, supposing the intensity of the source of illumination to be the same in both cases, for the former collects, upon a few points, all those rays, which the other would have employed in illuminating, at once, every portion of the horizon.

It might be thought possible to combine the superior brightness of a revolving with the constancy of a fixed light, by increasing its speed, so as to cause its flashes to succeed each other so rapidly, as to produce a continuous impression on the eye. This idea actually occurred to the late Captain Basil Hall, who proposed such an arrangement; and the efficiency of his plan was tested by Mr. Alan Stevenson, engineer to the Commissioners of Northern Lights. He found that when a frame carrying 8 lenses was made to revolve with increasing rapidity, the brightness of its flashes, seen at a distance of 14 miles, continually diminished; until, at length, when a velocity of 8 or 10 flashes in a second had been attained, the light became almost invisible. This rapid diminution of the brightness of the light, consequent upon an increased velocity of rotation, is correctly ascribed, by Mr. Stevenson, to the light not having had time to produce its full effect on the eye. While Mr. Stevenson's experiments show the impracticability of Captain Basil Hall's ingenious proposal, we are still unacquainted with the greatest velocity which may be communicated to a revolving light, without necessarily diminishing its apparent brightness. The author's recent experiments on the *Gradual production of luminous impressions on the eye*, published in the Transactions of the Royal Society of Edinburgh, for 1849, afford the means of assigning a limit to this velocity, beyond which we cannot pass without necessarily impairing the brightness of the light.

By causing an opaque disc, having a sector of a known angle cut out of it, to revolve, with a given velocity, between the eye and a luminous object, at each revolution the light acts on the eye for a short interval of time, of which the duration is easily calculated. In this manner the author compared the apparent brightness of an aperture in a screen, covered with ground glass, and illuminated by a flame of constant intensity, seen behind a revolving disc, with that of a similar aperture seen in optical contact with the other, and whose brightness could be varied by altering the distance of a light placed behind it. He thus obtained numerical values for the brightness of impressions of short duration, compared with the full effect the light was capable of producing on the eye. Among other results of his experiments, it was found that *light requires nearly* $\frac{1}{10}$ *of a second to produce its full impression on the eye;* and that, for shorter intervals of time, *the brightness of the impression is sensibly proportioned to the time in which it has been produced.* Thus, an impression made in $\frac{1}{100}$ of a second, has almost exactly $\frac{1}{10}$ of the brightness of the light seen by continuous vision.

It follows from this, that in a revolving light, each flash ought to be allowed to act on the eye of a distant observer for more than $\frac{1}{10}$ of a second, in order that its light may have time to produce a full impression. Assuming the arc of the horizon illuminated at once by the brightest part of the flash, to be equal to the minimum divergence of the rays, and putting a to denote this angle, expressed in degrees, which may be found by calculating the angle subtended by the horizontal diameter of the flame at the most distant point of the lens, or reflector, in the same horizontal plane with it; then, if t be put for the time, in seconds, of a complete revolution of the apparatus, the time each flash acts on the eye will be $\frac{a\,t}{360}$. Now, in order that the light may have full time to act on the eye, the duration of the flash should exceed $\frac{1}{10}$ of a second, from which it follows that $t > \frac{36}{a}$.

In assigning this limit to the time of a complete revolution, it is not, of course, assumed, that it would be safe to approach it very closely in practice. All that is meant to be affirmed is, that any proposed arrangement which would assign a greater velocity, may safely be rejected *priori* as disadvantageous.

INSTITUTION OF MECHANICAL ENGINEERS.

ROBERT STEPHENSON, ESQ., PRESIDENT, IN THE CHAIR.

"On the importance of making a Compensation for the pull of the Air-pump Bucket in the Condensing Steam-Engine," by Mr. George Heaton, Birmingham.

In the year 1844, the author of the present paper was employed to inspect and ascertain the cause of the irregular motion and inefficient performance of a steam-engine and mill, used for the purpose of grinding corn. The mill had nine pair of corn stones, five on one, and four on the other side of the driving power. The bottom of the corn spindles frequently moved, and strained the whole framing which carried them, those most distant from the power having the greatest strain, frequently moving a quarter of an inch, and the end of the horizontal shaft which drove the corn spindles partaking of the same movement, and becoming much heated with its work, and the teeth of the wheels much worn on both sides.

The mill-work was very good and substantial, and had been about four years at work. The steam-engine, with cylinder 40 inches diameter, stroke of piston 6 feet, air-pump 26½ inches diameter, and 3 feet stroke, was altogether a strong well-built engine; the steam pressure was about 6 lbs. per inch, and the engine was working at 17¾ strokes per minute; but, if attempted to be run faster, a much more irregular motion was produced. The governor was driven with gear, at the top of a vertical shaft 14 feet long, and the balls of the governor frequently moved in and out 4 or 5 inches during one stroke of the engine. When running at the speed of 17¾ strokes per minute, the governor rod, at the throttle-valve lever, frequently moved ¾ to 1 inch during each stroke of the engine, the greatest opening of the valve being invariably at the end of the pull of the air-pump bucket; there was a great variation in the distance the rod moved each stroke, moving the farthest every fourth or fifth stroke. The engine appeared to have too much lead, for the reversing blow was struck before the crank arrived at the centre. The time of opening the valves was therefore altered, effecting a saving of steam, and requiring the governor rod to be shortened more than one inch (the throttle-valve lever being 12 inches long); however, the irregular motion continued, and the engine, with nine pair of stones, appeared to have too much work.

The engine was constructed according to the general practice, to have about an equal weight hanging upon each end of the beam; the weights of the different parts were stated to be as follows:—

AT THE CRANK END.

	T.	cwt.	qrs.	lbs.
Connecting rod and block at the top,	1	11	3	14
Four brasses,	0	0	2	0
Cold water-pump bucket and rod,	0	2	2	0
Crank and pin,	0	14	3	0
Feed-pump, plunger, and rod,	0	2	0	0
	2	11	2	14
Deduct for weight of crank balanced on the main shaft,	0	9	0	0
Total weight,	2	2	2	14

AT THE CYLINDER END.

Piston rod,	0	4	1	19
Piston and ring,	0	14	1	0
Pins, gibs, and cotters for ditto,	0	1	0	21
Parallel motion,	0	11	3	0
Cap and gudgeon to piston rod,	0	4	0	0
Plug rod,	0	3	2	0
Air-pump bucket,	0	4	2	0
Total weight,	2	3	2	12

consequently, the weights at each end of the beam were balanced within 1 cwt.

The following alteration was then effected in the engine:—

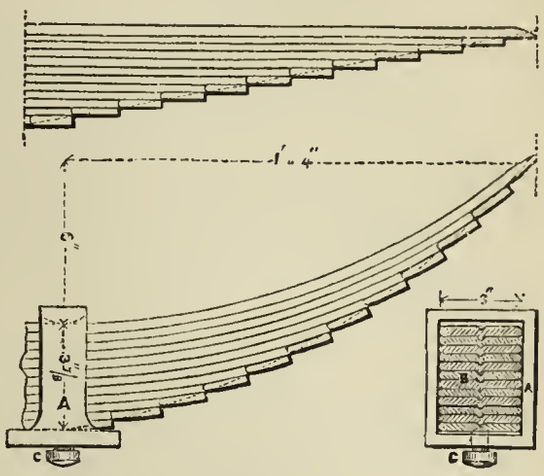
A weight was fixed at the crank end of the engine beam, to assist in the pull of the air-pump bucket, and retard the speed of the engine on the opposite side of the stroke. This weight was 19 cwt. 3 qrs. 14 lbs., and from its position it was equivalent to about one-half the pull of the bucket, considering the average pull through the whole lift. The engine beam was double, and the balance weight was fixed between the two sides of the beam; also the governor was altered to be driven by a band instead of the former gear and long shaft. The engine was then set to run at 19½ strokes per minute, the speed required by the Company for its work, so as to drive the stones at about 128 revolutions per minute, instead of about 117, the former speed; the corn spindles then ran quite steady, the necks of the horizontal shaft kept cool, the dust remained on the back part of the teeth of the driving wheels, and the governor rod remained steady for a long time together, without anything else being done to either the engine or mill. Since that time, the Company have added five pair more corn stones to that end of the shaft the five pair are at, and they run equally steady with the others. The engine appears now to drive thirteen pair of stones with greater ease and freedom than it drove eight pair before the balance weight was added, and the repairs have been considerably diminished in the same space of time.

"On Railway Carriage and Waggon Springs," by Mr. W. A. Adams.

In the paper read at the last meeting,* the writer brought before the Institution some experiments on the relative qualities of spring-steel, manufactured from English and from Swedish iron, and gave a description of the different constructions of bearing and buffer springs, making a comparison between the laminated buffer springs and the various kinds of external cylinder and piston buffers.

An investigation was also given of the principles for regulating the form and thickness of the plates of the ordinary laminated springs, and the writer endeavoured to illustrate that the true and correct form for a laminated spring is a triangle tapering at a uniform rate from the centre to each end; and, further, that the spring should not be weakened in the centre by a bolt or rivet hole. He intimated his intention of preparing a laminated bearing spring with axle-box and adjustments complete, according to these principles, and thus endeavour to produce the same results as in the ordinary laminated spring with the smallest amount of material.

Fig. 1.



1-8th.

Fig. 1 represents a spring and adjustments of the following dimensions, which has been made according to the above principles, and is laid before the present meeting:—

Length,	2 ft. 8 in.
Camber,	6 in.
Width,	3 in.
Thickness in centre,	3⅞ in.

Consisting of 10 plates $\frac{5}{16}$ inch thick, and 2 plates ⅜ inch thick.

The weight of the spring, exclusive of the hoop, is 59 lbs.

This spring is very nearly a triangle, the base being but ¼ inch wide. To ensure the correct triangular form, the plates are cut to the correct lengths, as shown in fig. 3, and afterwards cambered.

In this spring there is no rivet or bolt hole, the plates being held together by the clip A. The clip is rounded at the top and bottom, as shown in the section fig. 2, and the spring is therefore confined at the extreme centre only.

To prevent the plates sliding one past the others, they are studded one into the other at the centre, as shown at B, fig. 2. To prevent the spring sliding from the hoop, a set screw, C, figs. 1 and 2, is fixed in the bottom of the clip, the point of the set screw fitting a countersink in the bottom plate. The clip or saddle, A, is broad at the base to enable it to rest conveniently on the sides of the axle-box, in the manner of an ordinary spring hoop, without interfering at all with the grease chamber.

The deflections of the above spring are by actual experiment.

½	ton weight,	½	inch deflection.
1	"	1	"
1½	"	1½	"
2	"	2	"
3	"	3	"
4	"	4	"

No permanent set in this experiment.

"On an India-rubber Buffer," by Mr. De Bergue.

In reference to the observation that the sustaining power of the India-rubber buffers is too great, and that in the event of a collision the train might collapse before this was fully developed—the writer would observe, that the most effective buffers, in the event of a collision, will be those which will oppose the greatest amount of resistance moving through the greatest space, provided their maximum resisting force should not exceed the pressure that could be sustained by the under frames of the waggons without injury. Now the maximum sustaining power of a pair of these India-rubber buffers does not exceed 20 tons, and as there are several thousand sets of them in use, many of which have at times been driven quite home without the waggons being collapsed, it follows that their resisting power does not exceed a *useful* limit, and that they must consequently be much more efficient in the event of a collision, than any other buffers having the same stroke and only one-third of the resisting power.

But it must be borne in mind that buffers are not solely required for cases of collision, they are more generally serviceable to break the slighter concussions in stopping and starting trains and in sidings and warehouses; and in order that they should be appropriate to this service, their resisting force must be comparatively very small at the commencement of the stroke; no spring yet produced combines these properties so perfectly as the vulcanised India-rubber; indeed, it is so easily acted upon at the commencement of the stroke, that it has been found advisable to compress the four rings in each buffer to the extent of one inch before the stroke commences.

* See p. 68, *Practical Mechanic's Journal* for June.

If the immense sustaining power of these buffers were objectionable, it could be reduced to any required amount, simply by decreasing the diameter and thickness of the rings, which would also lessen the cost—but, in the opinion of the writer, that would be destroying one of the most valuable properties of these buffers.

A comparison has been made between the relative proportions of effective resistance of a pair of buffers of 12 inches stroke with the ordinary laminated spring, and a pair of the India-rubber waggon buffers; but, in the writer's opinion, the calculations are incorrect. It has been assumed that the India-rubber buffers have only $1\frac{1}{2}$ inch stroke with a final resistance of 3 tons: say 3 tons $\times$ $1\frac{1}{2}$ inches $= 4\frac{1}{2}$ effective resistance of a pair of India-rubber buffers. Then 12 inches is given as the stroke of the laminated spring with $2\frac{3}{4}$ tons, which would make $2\frac{3}{4}$ tons $\times$ 12 inches $= 33$ effective resistance, the proportion being $4\frac{1}{2}$ to 33, or 1 to $7\frac{1}{3}$.

But as regards the India-rubber buffers, the length of stroke is exactly 3 inches, and the maximum resistance 20 tons for a pair; and as this large amount of resistance is mainly accumulated towards the end of the stroke (as will be seen from a statement of experiments annexed), it would not be correct to take the half of that as the average resisting power; but it is presumed that it will be keeping within the limits to take only one-quarter of the maximum resistance; say 5 tons, as the average resisting power for a pair of buffers, thus: 5 tons $\times$ 3 inches $= 15$ effective resistance.

With regard to the laminated spring, $2\frac{3}{4}$ tons is given as the resisting power of the spring for the pair of buffers with 12 inches of action; but this $2\frac{3}{4}$ tons is the *maximum* resistance of the spring deflected to a straight line, and being a steel spring, and its resistance not increasing in the same compound ratio as the India-rubber, nearly half its maximum power should be allowed as the average resistance throughout the stroke; say $1\frac{3}{8}$ ton $\times$ 12 inches $= 16\frac{1}{2}$ effective resistance; thus it appears that the proportionate effective resisting force between a pair of the India-rubber 3 inches stroke waggon buffers, and a pair of 12 inches stroke ordinary laminated spring buffers, is as 15 to $16\frac{1}{2}$, instead of being as 1 to $7\frac{1}{3}$.

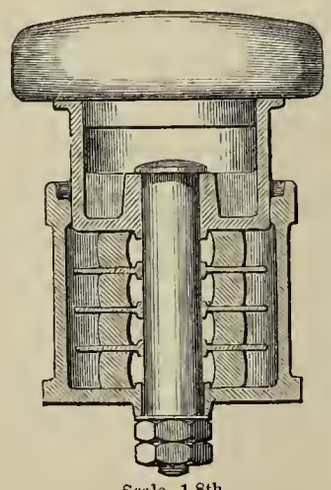
It may be here observed that the India-rubber buffers are not limited to 3 inches stroke; some are made $4\frac{1}{2}$ inches, and some with 6 inches stroke for passenger carriages, and their resisting power is proportionately increased, but this incurs additional expense, which is a matter of no small consideration in the present times, and it is found from lengthened practice that the 3 inches stroke buffers are quite sufficient for all classes of goods waggons, and even for cattle trucks, luggage vans, &c. The size of the India-rubber rings in these 3 inches stroke buffers is $5\frac{1}{4}$ inches diameter and $1\frac{1}{2}$ inch thick.

With respect to the durability of the vulcanised India-rubber, a reference has been made to elastic bands for papers that have become completely rotten; but it will be sufficient to state the fact that a great quantity of these bands have been made that were never "vulcanised" at all, and were manufactured under an independent patent for "converting," but they were sold by the same parties, and the public did not know any difference. The India-rubber rings used in the buffers are all vulcanised, and the writer has examined many of them that have been at work for several years, and he has not yet met with a single instance of a bad one.

It has been objected to the external cylinder buffers, that the piston or plunger is guided through too short a space, which makes it more liable to break the cylinder in the event of an oblique blow; but it should be observed that this defect is obviated in the India-rubber buffer, where the length of the bearing extends from the mouth of the cylinder to the end of the boss on the base plate, the spindle being fitted so as to form a solid body with the plunger. The India-rubber buffer is superior, in the writer's opinion, to the other external buffers, in efficiency and durability, whilst equally compact and economical, as the resistance begins very gradually at the first part of the stroke, and increases to a great power at the latter part, without coming to a dead stop at a moderate pressure, as in the other buffers; the pressure being spread uniformly over the whole surface of the base plate, which is better adapted to preserve the waggon frame from injury, and the elastic material is not liable to break as steel, whether in the form of a spiral or otherwise.

The following table shows the actual compression of one of these India-rubber waggon buffers of 3-inch stroke, with each increase of pressure from $\frac{1}{4}$ ton up to 10 tons, tried with great accuracy in a machine made for the purpose:—

Pressure in Tons.	Amount of Action in Inches.
$\frac{1}{4}$	·125
$\frac{1}{2}$	·625
$\frac{3}{4}$	1·063
1	1·344
$1\frac{1}{4}$	1·694
$1\frac{1}{2}$	1·750
$1\frac{3}{4}$	1·906
2	2·031
$2\frac{1}{2}$	2·219
3	2·375
4	2·563
5	2·750
6	2·813
7	2·875
8	2·938
9	2·969
10	3·000



Scale, 1-8th.

SOCIETY OF ARTS.

JULY 22—SESSION 96.

THE LORD COLBORNE, VICE-PRESIDENT, IN THE CHAIR.

The Address of the Council, at the annual general meeting of this time-honoured Society, shows that it has just completed "one of the most prosperous sessions which it has enjoyed for many years." This prosperity is evidenced by the late great increase in subscribing members; for whilst the annual average of new members, elected from 1845 to 1849, was only 105, the books of the past session exhibit an accession of no fewer than 250.

On the eve of the great Exhibition of 1851, it could not be expected that the other section of the Society's annual exhibition, that, namely, of British manufactures, would present any very remarkable features. It consisted of articles submitted in competition for the prizes offered by the Society—these being mainly woven and printed fabrics. Among them the following are worthy of notice:—

The wide furniture-damask of Messrs. Keith and Co.; the wide ribands of Messrs. Cornell, Lyell, and Webster; the machine-made lace of Messrs. Reckless and Hickling; the tamboured lace of Messrs. Lambert and Bury, interesting on account of the new branch of industry which it has afforded to the very poor population of a part of Ireland; and the printed shawls of Messrs. Keith and Shoobridge. The wood-carvings of Mr. Wallis also deserve honourable mention.

The same cause that has prevented the exhibition of British manufactures from rivalling its predecessors, has also, though not to the same extent, affected the communications made in the departments of mechanics and trade and manufactures. In the former, some of the communications for which rewards have been adjudged are of great value. The gold medal of the President for improvements in the machinery or processes employed in the cultivation or preparation of sugar in the British colonies has not been awarded; but the new cane-press of Mr. Bessemer, for which that gentleman will receive the Society's large gold medal, though applying only to one part of the process in which a general improvement would appear to be contemplated by His Royal Highness, has the merit of introducing a principle at once new and of great beauty into that process; while, by reducing the weight and cumbrousness of the machinery, much has been done by Mr. Bessemer towards removing the main obstacle to improvement in the working machinery of the colonies of the tropics, viz., difficulty of transport.

The condenser of Mr. Siemens—a gentleman already well known, both to the mechanical world and to the members of the Society, for several inventions of a very high order—has also the merit of being the development of a new principle, and as such, as well as for the ingenious manner in which that novelty has been carried out in the detail of construction, it has been deemed by the Council worthy of the large gold medal.

As an example of an article of manufacture, in the production of which all attempts had hitherto been unsuccessful, but which has at last been accomplished just when most needed, is to be noticed the full-sized bath in Stourbridge clay of Messrs. Rufford and Finch, for which the gold Isis medal has been awarded to those gentlemen. For the production of this article a prize was, at the special suggestion of the President, offered by the Society in the session of 1846-7, with a view to the assistance of the movement for people's baths and washhouses, then in its infancy.

The goblet, which last year the Council announced as being in preparation from the designs of Mr. Maclise, R.A., in accordance with the provisions of the Swiney bequest, has been perfected, and the cup has been for some time before the Society.

From the following list of rewards presented by the Vice-Chairman of the Society, Lord Colborne, it will be seen that a Glasgow firm, Messrs. E. Henry and Sons, has carried off one of the *Gold Isis Medals.*

SECTION OF TRADE AND MANUFACTURES.

1. Messrs. Rufford and Finch, for their Porcelain Bath in one piece—*The Gold Isis Medal.*

SECTION OF FINE ARTS AND MANUFACTURES.

2. Messrs. Campbell, Harrison, and Lloyd, for their Figured Silks for Dresses—*The Gold Isis Medal.*
3. Messrs. John Crossley and Sons, for their Printed Carpets—*The Gold Isis Medal.*
4. Messrs. Ebenezer Henry and Sons, for their Embroidered Garment Fabrics—*The Gold Isis Medal.*
5. Messrs. Keith and Co., for their Silk Furniture Damasks—*The Gold Isis Medal.*
6. Messrs. Lambert and Bury, for their Tamboured Lace—*The Gold Isis Medal.*
7. Messrs. Reckless and Hickling, for their Machine-made Lace—*The Gold Isis Medal.*
8. Messrs. Swainson and Dennys, for their Sweet-Pea Chintz—*The Gold Isis Medal.*
9. Messrs. George Bacchus and Sons, for their Specimens of Table Glass—*The Silver Medal.*
10. Messrs. Cornell, Lyell, and Webster, for their Seven-inch Ribands—*The Silver Medal.*
11. Messrs. Keith, Shoobridge, and Co., for their Printed Shawl—*The Silver Medal.*
12. James Coulson, for his Damasks—*The Silver Medal.*
13. Miss Stanley, for her Norwich Hand-made Lace—*The Silver Medal.*
14. Messrs Stone and Kemp, for their Silk Damasks—*The Silver Medal.*
15. T. W. Wallis, for his Specimens of Carving in Wood—*The Silver Medal.*
16. Edward Webb, for his Horsehair Damasks—*The Silver Medal.*
17. Messrs. J. and W. Wilson, for their Carpets—*The Silver Medal.*

18. Messrs. R. S. Cox and Co., for their Seven-inch Ribands—*The Isis Silver Medal.*
19. George Cook, for his Specimens of Carving in Wood—*The Isis Silver Medal.*
20. Mrs. Temple, for her Flowers in Wax Composition—*The Honorary Testimonial.*
21. Manager of the School of St. Clare, for Specimens of Knitting, executed by the Children under her charge—*The Honorary Testimonial.*
22. Johan M. Levien, for his Introduction and Application of New Zealand Woods for Furniture—*The Honorary Testimonial.*
23. W. Potts, for his Ornamental Metal-Work—*The Honorary Testimonial.*

SECTION OF CHEMISTRY.

24. Messrs. MacNair and Co., for their Coating for Electric Telegraph Wires—*The Silver Medal.*

SECTION OF MECHANICS.

25. Henry Bessemer, for his Sugar-Cane Press—*The Gold Medal.*
26. C. W. Siemens, C.E., for his Regenerative Condenser—*The Gold Medal.*
27. George Heaton, for his Plan for preventing Oscillation in Locomotives—*The Isis Gold Medal.*
28. William Henry Smith, C.E., for his Flexible Breakwater and Lighthouses—*The Isis Gold Medal.*
29. Antoine F. G. Claudet, for his Glass-cutting Machines—*The Silver Medal.*
30. Thomas Syson Cundy, for his Pyro-Pneumatic Stove—*The Silver Medal.*
31. John Imray, for his Investigation of the Action of the Crank—*The Silver Medal.*
32. Duncan Mackenzie, for his Reader for Jacquard Looms—*The Silver Medal.*
33. William Melvine, for his Aphonetic Clock—*The Silver Medal.*
34. William Pole, for his Investigation of the Action of the Crank—*The Silver Medal.*
35. Cornelius John Varley, for his improved Air-Pump—*The Silver Medal.*
36. Francis E. Colegrave, for his Spring Saddle-Girth—*The Isis Silver Medal.*
37. Goodhue, Clinton, and Co., for their Method of Constructing Metallic Attachments to Mineral Substances—*The Honorary Testimonial.*
38. J. E. M'Douall, for his Vibrating Archimedean Drill-Stock—*The Honorary Testimonial.*
39. James Veitch, M.D., R.N., for his Medico-Chirurgical Ambulance—*The Honorary Testimonial.*

The intimate connection of the Society with the great Exhibition of 1851, has led to the publication by the Society of a *Special* Prize List for 1850-51, for the encouragement of the production of philosophical treatises, bearing upon the presumed effect of this great experiment upon the arts, manufactures, and commerce of the country. The Council accordingly offer the large medal and twenty-five pounds for the best, and the Society's small medal and ten pounds for the second-best treatise on the objects exhibited in the section of Raw Materials and Produce.

A large medal and twenty-five pounds for the best, and a small medal and ten pounds for the second-best treatise on the objects exhibited in the section of Machinery.

A large medal and twenty-five pounds for the best, and a small medal and ten pounds for the second-best treatise on the objects exhibited in the section of Manufactures.

A large medal and twenty-five pounds for the best, and a small medal and ten pounds for the second-best treatise on the objects exhibited in the section of Fine Arts.

Each treatise must occupy, and not exceed, eighty pages of the size of the Bridgewater Treatises.

The Society will also award its large medal and twenty-five guineas for the best general treatise upon the Exhibition, treated commercially, politically, and statistically; and small medals for the best treatises on any special object or class of objects exhibited.

The treatises for which rewards are given are to be the property of the Society; and if deemed suitable for publication, should the Council see fit, they will cause the same to be printed and published, and will award to the author the net amount of any profits which may arise from the publication after the payment of the expenses.

The treatises to be delivered at the Society's House on or before the 30th of June, 1851.

ROYAL SCOTTISH SOCIETY OF ARTS.

February 11, 1850.

"An Exposition of the Art of Navigation, as applicable to Inland Transit, and of the Works by means of which our Communication with the Ocean is improved and maintained," by David Stevenson, Esq.

But without alluding further to other important ship-canals, he went on to consider the improvement and maintenance of tidal navigations, which formed the sea accesses to the chief ports of this country; and without entering on other arguments in order to prove the importance of that branch of the subject, he had only to remind the society that the trade of London, Liverpool, Newcastle, Glasgow, Dundee, and by far the greater proportion of the second class ports, was solely dependent on the maintenance of the tidal navigations, which, if he might use the expression, formed their only *highways* of communication with the ocean.*

In introducing this subject, he would endeavour to explain what was implied in the word "tidal," as used in particular with reference to British ports, as he apprehended there was much more importance to be attached to the term than those who had not studied the subject were probably aware of; and he believed he would best explain this by drawing a comparison between Britain and some large tract of continental country, such, for example, as North America. We there found capacious rivers extending for hundreds, he might say thousands, of miles into the interior of the country, and discharging an enormous amount of fresh water into sheltered and deeply indented bays—these indentations in the line of coast bearing, in fact, some proportion to the sizes of the rivers which flowed into them; and such a physical formation afforded facilities of no ordinary kind, not only for the establishment of safe harbours on the sea-coast, without the expenditure of capital in their protection, but also for the extension of inland navigation to an almost unlimited degree, by means of the rivers themselves.

To give a practical idea of this, he stated that when he visited America, twelve years ago, he came to the conclusion, after examining the principal harbours on the sea-coast, which afforded most perfect shelter and a great amount of accommodation, that the formation of the smallest of our post-office packet stations in the Irish Channel had consumed a much larger expenditure of capital than the Americans have found it necessary to invest in the formation of harbour accommodation for trading vessels along a line of coast of no less than 4,000 miles, extending from the Gulf of St. Lawrence to the Mississippi. With reference to the rivers which discharged into these bays, it was impossible in words to convey an adequate idea, or to describe the feelings which the traveller experienced when, for instance, after crossing the Alleghany Mountains, and completing a fatiguing land journey from the eastern coast of several hundred miles into the interior of the country, he first came in sight of the river Ohio at Pittsburg. There, in the very heart of the continent of North America, he found a large shipping port, containing a fleet of between thirty or forty steamers, varying from 300 to 700 or 800 tons burthen, moored in the river; and his astonishment was still more increased, if he chanced to witness the arrival of one of those steamers, and was told she had come direct from New Orleans in the Gulf of Mexico, and that fifteen days and nights had been occupied in making her *inland voyage* of no less than 2,000 miles among the meanderings of the Mississippi and Ohio!*

But Mr. Stevenson stated that with us the case was altogether different—the isolated and comparatively contracted limits of our country did not afford area for the collection of such bodies of fresh water. In proof of this, he referred to the comparative areas of the basins, and the discharges of different rivers, viz.:—

	Area square miles.	Discharge.
Thames,	3,500	80,220
Tay,	2,283	273,117
Clyde,	1,270	94,000
Mississippi,	982,400	24,600,000

Our streams could therefore, he said, be advantageously navigated only when their waters were deepened by the influx of the tide, and they were consequently closed to all vessels, excepting those of the smaller classes, during the absence of tidal influence; and therefore our rivers, when compared to those of our transatlantic or even continental brethren, could only be regarded as narrow creeks or inlets, kept open by the joint action of the fresh-water stream and the tide; and as the action of the fresh water varied in its extent, and was at best but feeble, that our great stronghold in keeping open and deepening our navigations must be sought for in the action of the tide, which not only scoured and maintained in a navigable state the sea-channels of our rivers and estuaries, but also by its presence increased their depth of water. It was likewise, he said, to be noticed, that the fall or inclination of these large continental rivers has been found to be exceedingly small: for example, the inclination of the following rivers had been estimated to average, from their source,†—

	Per mile.
The Mississippi,	3 inches.
The Amazons,	5 —
The Ganges,	4 —
While the Thames was	21 —
The lower part of the Dee,	11 —
The Lune,	23 —
The Forth,	13 —

The currents of the larger continental rivers were, therefore, more languid and more easily navigated, whereas the currents of our rivers were more powerful and less easily overcome. But here, again, an important advantage was derived from the tidal influence, which produced an upward current, by which vessels were enabled, without the aid of steam or wind, to reach their port; and he thought that was a view of the subject which could not fail to have struck the most superficial observer, when he saw on any of our navigable rivers or estuaries (such as the Thames or the Mersey) a vast fleet of vessels of all sizes and from all countries, hurried on by the silent but powerful energy of the flowing tide. What an amount of latent power lay there! And how invaluable was that agency to the commerce of this country! If, indeed, the natural power latent in the *tides* of the Thames and the Mersey were suspended, it might truly be said of the *steam* power employed on the net-work of railways connected with London and Liverpool, that its occupation would be gone. Whatever, therefore, had for its object the improvement or maintenance of tidal navigations was, he submitted, of vast importance to the commerce, and entitled to the attention of our country.‡

* History of Inland Navigation, particularly those of the Duke of Bridgewater. London, 1786.—Hughes' Memoir of Brindley, Weale's Quarterly Papers. London, 1843.

* Stevenson's Sketch of Civil Engineering in North America. London, 1838.

† Traill's Physical Geography. Edinburgh, 1838.—Johnston's Physical Atlas. Edinburgh, 1849.

‡ Stevenson on the Improvement of Tidal Rivers. London, 1849.

Mr. Stevenson then proceeded to explain that the chief obstructions to the propagation of the tides were the circuitous routes of rivers—the slopes of their beds—the projections of obstacles into their streams; and that the works by which these obstructions could be best overcome consisted in the deepening, straightening, and widening of the channels—the formation of new cuts—the erection of low rubble walls for the guidance of the currents of the first of flood and the last of ebb tide—the shutting up of subsidiary channels—and the removal of projecting groins. That the more rigidly that class of works was adhered to, the more generally beneficial would be the effect produced; for not only did they improve the part of the navigation where they were executed, but that their tendency was to increase the back-water by which the sea channels were kept open. He then proceeded to illustrate these views by referring to the Tay, Forth, Ribble, Lune, and other rivers, where the duration of the tidal influence had been prolonged from thirty minutes to an hour, and the range of tide increased from two to five feet, while the navigation in all cases had been proportionally improved. Time did not admit of Mr. Stevenson's alluding to many other examples of importance, but the Clyde might be cited as a proof of the length to which such improvements had been carried. In 1755, Smeaton proposed to improve that river by erecting a dam across it with locks in the lower part of the river. In 1775, Golburn surveyed the river, and reported that, as far down as Kilpatrick, there were only two feet of water in it, but conceived that the river itself might be improved. In 1831, vessels drawing 13 feet 6 came up to Glasgow, and now large vessels, three or four deep, are to be seen ranged along each side of the harbour. During 1834, 27,000 vessels passed Renfrew ferry, at some periods from twenty to thirty of them in an hour.* He next stated, that as an engineer could not form a design for such improvements without accurate data, it was of the highest importance to obtain correct information as to the tides, currents, and discharge of rivers, as well as the nature of their beds, and other particulars; and proceeded to explain how these data were obtained, and showed the different instruments for ascertaining the velocities of surface and under currents, and for procuring specimens of water from different depths; but for details on all these points, he referred to his treatise on marine surveying.†

He farther referred to the plans of the Tay, the Ribble, Mersey, Dee, Lune, &c., to show that in each of these rivers there existed a large basin or estuary, into which the tide flowed, and from which it was discharged twice in twenty-four hours, and stated that it was the flux and reflux of the large volume of tidal water from these natural basins which scoured the seaward channels, kept down the tracts of sand-banks by which their entrances were encumbered, and maintained a navigable depth of water over their bars. The instances to which he referred were all what were termed bar rivers or harbours, in contradistinction to such rivers as the Forth or Clyde, which had not similar obstructions. The fact of the existence of a strong tidal under current was adduced to prove the effect of the flood-tide as a scouring agent, and it was stated that, while the fresh water, being specifically lighter, floated on the surface, the tidal current flowed in a stronger current below. He instanced, in proof of this, various examples, particularly the observations of Professor Traill and Captain Sabine on the Orinoco and Amazons‡ (the fresh water from these rivers being traced at a distance of 200 and 300 miles from the land), and also observations by Mr. A. Stevenson in the Cromarty Firth, where the velocity of the under current, at the depth of fifty feet, was ascertained to be at least double the velocity at the surface. The depths of water on the bars of the Mersey and Dee, Mr. Stevenson stated, were only about eleven feet at low water of spring-tides, on the Ribble about seven, the Lune about six, and the Tay about sixteen; and in navigating such estuaries, vessels must wait for the proper time of tide, either to leave or enter them. It would readily occur, therefore, that the maintenance of the depth of water over the bar was of vital importance to all ports situated within tidal estuaries. From a careful investigation of such localities, he thought it might fairly be stated, that, so long as the capacity of the receiving basins remained entire, no fear need be apprehended of a decrease of water on the bar; and this view he was the more inclined to believe to be correct, from the circumstance that, in several cases where he had occasion to compare the present state of some navigations with their condition as represented in the early charts of Mackenzie, the celebrated marine surveyor, made upwards of half a century ago, he had found that, although the forms of the sand-bank and the direction of the navigable channel might have slightly changed, still there was no appreciable alteration on the depth of water on the bars; while, on the other hand, it had been pretty well established, particularly in the cases of Rye in Sussex, Southwold in Suffolk, and of Chester on the river Dee, and other places, that much injury had been caused by the embanking of land.§

The interests of proprietors of land along our rivers and estuaries were often at variance with those of the conservators of navigation, and the endeavours made in many instances to protect and reclaim land were calculated, from being injudiciously and too extensively carried out, to be highly prejudicial, and hence arose the obvious necessity for some board of appeal between the interests of proprietors and those of the public—a power which was vested in the Lords Commissioners of the Admiralty, to whom, as conservators of navigation, we were indebted for the preservation of many of our harbours and tidal rivers. So important, indeed, was this subject considered, that, on the motion of Mr. Hume, the Government, in 1844, appointed a Tidal Harbour Commission, to inquire into the state and condition of the harbours, shores, and navigable rivers of the United Kingdom, and to report what injury might have been done by encroachments or other interference with tidal waters; and, without detaining the Society longer, he thought he would best illustrate what is generally acknowledged to be the correct theory on this subject, by quoting the conclusion stated in the first Report of that commission, which is as follows:—That, "as a general, although not a universal principle, no cause has operated more extensively to injure the entrances of harbours throughout the United Kingdom, than excluding the tidal waters from lands below the level of high water, which served as natural reservoirs for the flood-tide, and were the means of affording a valuable scouring power during the ebb. Nor does any subject more deserve the vigilant attention of your Majesty's Government, or of those intrusted with the conservancy of our harbours, than such encroachments, which are usually made quietly and gradually, and, when once completed, are difficult afterwards to remove."

* Cleland's Statistical Documents. Transactions of the British Association. 1836.

† Stevenson on the Application of Marine Surveying and Hydrometry to the Practice of Civil Engineering. Edinburgh, 1842.

‡ El Maranam y Amazonas. Madrid, 1684.—Sabine's Account of Experiments to determine the Figure of the Earth. London, 1825. P. 445.

§ Reports of Tidal Harbour Commission. Rennie's Report on Hydraulics to the British Association.

ROYAL INSTITUTION, MANCHESTER.

October 16, 1850.

"On Voltaic Ignition and Illumination," by W. E. Staite, Esq.

The diverse opinions and hypotheses advanced by different philosophers in relation to the nature of heat—one of those agents commonly called "The Imponderables"—have tended not only to mystify scientific inquiry, but at the same time to lead the minds of the most acute astray from the consideration of the simple facts involved; facts, which if read by the light of common sense, and interpreted by the aid of allied phenomena, are by no means difficult of enlarged comprehension; that is, in relation to the constitution of this power.

The fall of an apple—a simple fact in itself—suggested to the capacious mind of Newton, the law of gravitation. And it is upon simple facts, after all, that the most sublime theories must rest, if they would rest securely; for, only so far as theory is based upon fact, proved and sustained by fact, but no farther, is it entitled to our respect, and the ready assent of our understanding.

The subject we have chosen for illustration this evening, is, "Voltaic Ignition and Illumination." This subject necessarily involves a consideration of those agents which are concerned in the production of the phenomena we have to consider—their connection and relationship, the one with the other, and the facts themselves.

In the first place, with regard to the nature and constitution of the imponderable agents—of which heat is one—as we have said, great diversity of opinion exists. If we were to ask twenty of our most distinguished philosophers for a definition of heat, we should probably have twenty different views and opinions expressed respecting it. Does not this arise, for the most part, from a too hasty generalisation of the simple facts, and a too rapid and inconsiderate promulgation of particular, though indefinite, views in respect of them? Again, others set their minds upon the task of solving the impossible problem of the abstract nature of these agents, instead of confining their attention to their constitution, as exhibited in their phenomena: deducing from one class of facts proved, a series of consequents and antecedents for which they have no authority, save inductive reasoning—each, in his own way, building up a theory, which, while it embraces the facts proved and those assumed, is made to account for almost everything which was previously obscure and mysterious, in relation to the subject. In this way, many errors now dead and buried in the tomb of science, have successively found their advocates and disciples. Causation, technically, is the rock on which science has so often suffered shipwreck; and, as long as we go on hungering and thirsting after causes—forgetting, or loosely considering, facts—just so long shall we continue to be tossed about on a perilous sea of doubt and difficulty.

Fact is the manifestation of law, and must ever be dependent upon it. The philosophy of Bacon was the true philosophy—the philosophy of fact deduced from experiment. By a law, we understand that which invariably acts under certain given circumstances, and under certain given conditions—laws being evidences of constant rules and ordinances. The laws of nature, taken as a whole, are all in harmony—there is no antagonism between them, if we rightly consider their operation; and if we speak sometimes of antagonistic principles, it should be in a very restricted sense, for the principles of nature can only operate and manifest themselves through the medium of matter; and matter, in all cases and under every diversity of condition, is obedient and subject to harmonious law—definite, unchangeable law.

By studying facts, then, we attain to a knowledge of the laws on which fact depends. We know that all the wondrous changes which are daily and momentarily taking place in the material universe around us, are not the results of chance, they are not accidental operations, but the direct evidences of law—the investigation of which should be the supreme object of all scientific inquiry.

Heat and light have long been considered by many as one and the same power, being subject to the same laws of reflection, refraction, and polarisation; but they are not inseparable. Bodies heated to 900 degrees radiate light, but below that temperature we have no perceptible light, only heat.

Mr. Grove, in his work entitled "Correlation of the Physical Forces," has given some ingenious and beautiful experiments illustrating the production of all the physical agents in series, from a given one. While fulfilling its immediate object very well, it is naturally incapable of exhibiting the completeness of the correlations. It shows B produced from A, and C from B, but not C from A. No single experiment can show how one agent may influence or be converted into any other, without using a third agent as a link of causation between them; yet it would not be difficult to show this direct connection in nearly all the cases.

If we regard heat, not as a separate force, but as an agent merely of primary force, and intimately connected with the other imponderable agents, we shall find that many of its phenomena, which admit only of doubtful and obscure interpretation on the 'latent' theory, become intelligible and consistent in this view, namely,

that heat is only one of the resultants of a great primitive initial force, just as the other agents are resultants; that is to say, motion or mechanical power, chemical affinity, electricity, magnetism, light; and we may, perhaps, add to these, with propriety, yet another, which we will call neuralism, as representing the nervous power in man and animals.

If we carefully note the facts and phenomena exhibited by these agents, can we rationally conclude that they are separate forces? For, we may ask,—Can we produce chemical affinity without motion? Can we produce electricity without motion, or chemical affinity? Can we produce magnetism without motion, or without electricity? Can we produce heat without motion, or without chemical affinity? Can we produce light without motion, heat, or chemical affinity? As to neuralism, it seems to be so intimately associated with electricity and chemical affinity (quite as closely as magnetism is with electricity), and yet having distinct phenomena, as to warrant us in placing it in the rank of a separate agent. Further, taking any one of these agents as an initial power, we can produce, either directly or indirectly, all the other agents from it. If these were separate and distinct forces, they would be independent the one of the other; whereas, it is clear no one of them can be produced without the agency of the other, except, perhaps, motion; and as motion implies the idea of a mover, motion may very well be placed in the centre of the system,—as the principal exponent of the great central dynamic pervading influence,—the first great cause,—the nature of which is, and ever must be, beyond the comprehension of the human intellect.

We assume, then, from the foregoing, what we hope presently to prove by experimental illustration, that these agents are agents merely, and not separate forces —"modified actions," we may term them, of one great force in nature; and dependent for their peculiar manifestations on particular conditions and states of matter; that is, whether the resulting phenomena be those which we associate with chemical affinity, or those which are commonly supposed to belong especially, solely, and exclusively, to heat, light, electricity, or any other agent: that they have one common origin, one common centre of being, and are not independent.

We shall find a simple and intelligible illustration of this in the voltaic pile, if we carefully consider its phenomena; and as our subject in this paper is "Voltaic Ignition," we will take the voltaic pile in preference to other illustrations, which could easily be offered.

Any one arrangement of voltaic elements and apparatus, may be said to be a type of the rest. Chemical action is the distinguishing feature of them all—dependent upon the laws of chemical affinity. Generally speaking, we employ two dissimilar metals, the one, in electric language, positive to the other. These metals have an electrolyte between them, consisting sometimes of acidulated water, or solutions of neutral salts and water, and sometimes water alone—such is a single-fluid battery. A double-fluid arrangement consists generally of two dissimilar metals also, but each metal in such cases is immersed in a separate solution. Two dissimilar metals are not absolutely necessary in double-fluid arrangements, as we have produced very powerful effects from the employment of one metal only. Now, the power and energy of all voltaic arrangements depend upon the nature of the elements employed, and the affinities between them; and the amount or quantity of that power which we term electricity, derived from chemical action, is exactly in the ratio of the oxidation of the positive metal (dependent upon surface in action) and the decomposition of the electrolyte; while the electro-motive force, or intensity, is dependent upon the affinities themselves.

MONTHLY NOTES.

The French Navy.—The following was the state of the French navy according to the official returns of the 1st of June last:—24 ships of the line afloat and 21 in the dockyard. These latter represent the force of 16 ships of the line at 22-24 of advancement, and 4 at 14-24; 38 frigates afloat and 18 in the dockyard, representing 10 at 22-24, and 6 at 14-24; 36 corvettes, 30 afloat and 6 in the dockyard; 51 brigs, 44 afloat and 6 in the dockyard; 38 transports, 15 of 800 tons, 12 of 500 tons, and 11 under 500 tons; 50 light vessels, of various tonnage: in all, 277. In mixed vessels there are—1 ship of the line of 100 guns, and 2 of 90 in the dockyard; 1 third-rate frigate afloat, 2 corvettes, used as advice boats, and 1 small vessel, the Pingouin, of 30-horse power. The steam navy is composed of 1 vessel of 960-horse power, and 21 frigates; 8 corvettes of the first class, 2 afloat and 6 in the dockyard; 21 corvettes of the second class, 20 being afloat and 1 in the dockyard; 34 advice boats of the first class afloat; 23 advice boats of the second class, 19 afloat and 4 in the dockyard; 2 iron boats of 30 horse power and 1 of 20 horse power, appropriated to the local service of Senegal—in all, 111 vessels. It appears, from an official return, that the cost of building and fitting out a French ship of the line, of three decks, and carrying from 110 to 120 guns, is 3,000,000 f.; one of 100 guns, 2,800,000 f.; and one of 90 guns, 2,500,000 f.

Peppe's Mercurial Time-Keeper.—We have recently seen a curiosity in the way of horologes which, without being exactly a modern antique, carries us back to the days of the *Clepsydra* or water-clock of the ancients, for in Mr. Peppe's invention the course of time is marked by the descent of a column of mercury through an adjustable orifice. This time-keeper—for we presume we must not style it a clock—is simple enough in its details, as it is little more than a bent or *endless* glass tube. It is made from a plain tube of some 3 feet in length, and about $\frac{3}{8}$th inch external diameter, with a bore of from $\frac{1}{16}$th to $\frac{1}{8}$th inch. At two determinate points in its length, this tube is fused in a blow-pipe, in order to slightly contract the bore at the parts fixed upon, and two pieces of wood, about $\frac{3}{8}$th inch long, are then pushed down tight into the contracted portions by a wire. Between these two wooden diaphragms another contraction is formed in the blow-pipe, the bore being reduced to $\frac{1}{2}\cdot\frac{1}{5}\frac{1}{0}$th of an inch. Mercury is then introduced into the tube sufficient to produce a column one inch in height, and the tube is afterwards bent in the middle, the two ends being brought round and fixed together, until it finally assumes the shape of a long flat-sided chain link. One leg of the tube thus formed has in it the two stop-pieces of wood, with the minute bore between them, whilst the other is of equal bore throughout; and it is in the upper part of the latter that the short mercurial column is supported. This support arises partly from the air beneath the column, and partly from the capillary attraction. Now as the stop-pieces or diaphragms are impervious to the dense mercury, they are permeable by air, and the portion contained between the mercury and these diaphragms finds its way slowly through, under the mercurial pressure. The mercury, of course, follows as the air escapes, and the descent of the column marks the lapse of time. To prevent oxidyzation in the tube, a short tube is drawn out at the top bend, and a drop of concentrated sulphuric acid, or purified oil, is introduced as a lubricator, the branch being then hermetically closed. Instead of the acid or oil, nitrogen or hydrogen gas may be used in the tube instead of air. A graduated cylinder of wood or white glass is clamped upon the tube in such a way as to be adjustable up or down, and the divisions are such as will indicate, in relation to the fall of the mercury, an hour or day—being determined by comparing the rate of descent with a chronometer. When in use, the tube is hung vertically, until the mercury reaches the bottom of its leg. It is then to be reversed, and the air, now on the opposite side of the diaphragms, is again forced through them as before. The mercury thus moves alternately in opposite directions, so that it is necessary to graduate the index cylinder on both sides in reverse ways—the graduations being extended for an hour or two beyond the time at which the tube is to be reversed, so that it is unnecessary to do this at any exact period, the time being set right on the plus or minus side by correspondingly altering the index. The inventor states that it is calculated for the measure of a very long period of time, as a month or year, by a reduction of the mercurial column and the air-escape. We cannot look upon this contrivance as a time-keeper for ordinary purposes—we ought rather to enter it on our list of curiosities; and give it here, not as an applied invention, but as a contribution to the general fund of ideas which the expansion of modern science greedily lays hold of and turns to useful ends.

American Marine Engineering.—Just now the Americans are putting forth their strength, making what the sporting man terms a "spurt," to get a-head of us in sea-going steamers for the Atlantic. The "Atlantic" is one of the results of this emulative strife, and, in the fair and smooth weather of summer, she has not, in the main, made a bad passage of it, although she has furnished an instance of that national rashness or over eagerness which so often attends the tremendous doings of our very forward neighbours: for, according to their own telling, she was "retarded for about thirty-six hours by accidents." The "Atlantic" and "Pacific" were expressly designed to beat our then best vessels of the Cunard line, the "Niagara," "Europa," "Canada," and "America," all Clyde-built and fitted; and, comparing the summer trips merely of these competitors, it is not to be denied that they have shown a good face. Now, however, we have two more, the "Asia" and "Africa"—also productions of the Clyde—great improvements even upon the four splendid ships just named, and the excellent behaviour of these two has again thrown our rivals into the background. The "Atlantic" and "Pacific" are sister ships, 290 feet long on deck, by 46 feet of beam, and 32 feet of hold—the engines having 95-inch cylinders and 9 feet stroke. The "Asia" and "Africa" are shorter, narrower, and of less depth—being 276 feet long, 40 feet 6 inches beam, and 27 feet 6 inches deep; whilst their engine cylinders are 96 inches diameter and 9 feet stroke, or slightly larger than those of the Americans. Our engineers have a tolerable notion of what is, and what is not, a good proportion of engine power to tonnage, as well as of the kind of model best adapted for Atlantic steaming. The Americans, however, thought they had still better ideas on the subject: the actual practice of each has shown which side was nearer the truth—and we may safely prophesy that winter service will tell still more strongly on our side. The "Editb" American steamer having been lately lost in the Pacific, the steam navy was reduced to six ships, which number has been increased to ten by building four new ones—the "Powhattan," "Susquehanna," "Saranac," and "San Jacinto." Norfolk has produced the first of these, Philadelphia the second, Portsmouth the third, and New York the last. The first pair are 250 feet long, and of 45 feet beam; the others are 196 feet long by 37 feet beam. The first pair have 70-inch inclined cylinders, 10 feet stroke; the third has also inclined engines, with 60-inch cylinders, and 9 feet stroke—all three being paddle steamers. The last is a screw-ship, with 60-inch inclined cylinders, and 4 feet 2 inches stroke, working across the ship. Unless it is that the engineers have objected to imitate or exhibit any signs of following our direct action or oscillating systems, we really cannot assign a reason for the excessive waste of space caused by the adoption of the inclined engines. The distance from bulkhead to bulkhead in the "Susquehanna" is actually 89 feet; this length, in the widest part of the ship, being entirely monopolised by the engines. It would appear that the engine-builders are not the designers of these engines—they merely make what are ordered by the executive heads of the government naval department—or we might expect that, upon the individual-designing system, each engineer, feeling the great responsibility attaching to him, would allow no trammels of private interest to interfere with his adoption of all the modern well-tested improvements.

Rutter's Electric Indicator.—The two little perspective views of this ingenious contrivance, given below, will afford a better explanation of the "notion," than any we can possibly give by a mere description, whilst they form an appropriate sequel to what we have said on the subject in our October number. Fig. 1 is an external elevation of the box containing the battery—in its position as shut up for use. Fig. 2 is an elevation of the corresponding box, with the front re

moved, to show the contained alarm apparatus with its actuating electro-magnet. In addition to the office of this apparatus, in pointing out the approach of danger

Fig. 1.

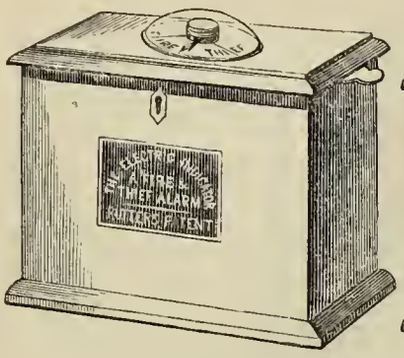
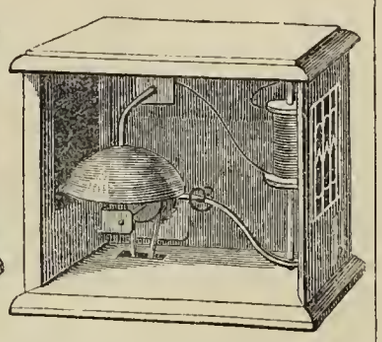


Fig. 2.



from fire in ordinary dwelling-houses and warehouses, the inventor specifies its peculiar applicability to ships. The awful terrors of "a ship on fire," demand every effort for their alleviation. Need we say that Mr. Rutter's plan deserves adoption for such a purpose? What may be hoped for from the further development of the extraordinary powers of electricity, is cleverly set forth by him in a few pithy sentences which may be not inappropriately repeated here—"The value of electrical agencies is beginning to be understood. They have their appropriate sphere, and that sphere is rapidly extending. No longer an experiment for the lecture-room, to be admired in proportion to its power, or brilliancy, or the skill of the manipulator—we are now setting electricity to work. Already has it done wonders. Obedient as the most dutiful child, tractable as a well-trained servant, swift to fulfil our commands as a ray of the brightest sunlight, it travels through the air by the road we have made for it, and with equal velocity through the earth by a road it makes for itself. Soon will it be traversing the bed of ocean; thus taking another step towards realizing the dream of the poet to

'Put a girdle round about the earth
In forty minutes,

and carrying from city to city, and from kingdom to kingdom,

'Thoughts which breathe and words which burn,'

by 'a path which the vulture's eye hath not seen.' But in thus accomplishing great things, let not smaller ones be neglected. Electricity must be familiarized with our homes; increasing their comforts by promoting the safety of our persons and the security of our property. It is exactly suited to our wants; silently and faithfully keeping watch and ward, neither getting weary nor making a mistake. If it cannot think for us, it does that which is still better, for it acts for us when we are incapable of thinking or acting for ourselves. If it cannot speak, it has no difficulty in making other agents vocal."

Decorations for the Exhibition Building.—Wood-carvers, decorators, and modellers, will shortly have an excellent opportunity of showing what they can do in their respective arts, in the actual decoration of the building for the great Exhibition. The Commissioners are so strongly impressed with the advantages which such a field will open up, that they have issued the following

MEMORANDUM ON THE DECORATIONS FOR THE BUILDING:—

Several applications have already been made by intending exhibitors to the Executive Committee, for the privilege of displaying *pavements*, *parquetrie works*, *fountains*, *ceilings*, and other similar objects in preparation for the Exhibition, as parts of the decorations of the building. The arrangements are now sufficiently matured to enable the Executive Committee to give the necessary information to parties who seek this privilege, and generally to consider any proposals of this kind which exhibitors may be desirous of submitting to them. The Executive Committee will, from time to time, make known the progress of the works, and the class of decorations for which they will be prepared to grant the privilege of adaptation. At the present time the Executive Committee beg leave to announce that they are prepared to receive offers from any intending exhibitors, whether native or foreign, for the exhibitions of *decorative ceilings*, *decorated iron railings*, *ornamental fountains*, *decorative works* in *scagliola*, *coloured cements*, and other *materials* for *walls*, &c. Wood-carvers, modellers, decorators, &c., desirous of executing specimens of ornamental ceilings, either in woodwork, plaster, papier-mâché, or flat coloured decoration, are informed that, generally speaking, the spaces to be appropriated to ceilings will be surfaces of 24 *feet* square, or 576 *superficial feet*, which will be seen at an elevation of about 19 *feet* from the ground. The spaces, which may be filled with scagliola, cement, and other wall decorations, will be 14 *feet* high, with semicircular heads, and 8 *feet* wide. The height, width, and nature of the *ornamental fountains* proposed for exhibition should be specified by the parties wishing to send them. Parties wishing to exhibit *decorated railings* may obtain the necessary information by applying to the Executive Committee. Any spaces allotted to exhibitors for these classes of objects will *not be included* in the allotments of space which may be made to them by any local Committee. Before the Executive Committee can make an absolute guarantee of space in these cases, they would be glad to receive a communication direct from the parties themselves proposing to execute such works, stating the details of their character, accompanied with sketches sufficiently descriptive. All proposals must be forthwith submitted to the Executive Committee.

Gutta Percha Tube Joints.—Gutta Percha fulfils no more useful office than that of a material for tubes of nearly all kinds; and as its adoption in this way is becoming universal, we have thought a few illustrative notes on the most approved plans of making the joints may not be out of place here. Fig. 1 exhibits a method to be used for straight tubes. The two ends of the tubes are to be placed in boiling water, until they expand to the bell form shown in the figures. All moisture is then to be wiped off, and the expanded portions are to be flattened out by gentle pressure, so as to turn them into regular flanges at a right angle to the axis of the tubes. These flanges are then to be nipped together with the thumb and finger, as in fig. 2, which is all that is necessary to form a strong joint; or if the greatest security is demanded, the surfaces may be rubbed with naphtha. When the junction is effected, the flange may be pared down to about half size if necessary. In fig. 3 another plan is given, wherein the junction is accomplished by the insertion of a short piece of tube between the two ends. After softening as before, the ends are to be enlarged in bore by a small iron tool. The surfaces are then to be dried, and a short piece of tube, of the length of the diameter of the ends to be joined, is to be inserted between them. The ends are then to be brought into contact and sealed with a warm iron, which experience has told us must not be too hot. Figure 4, is a section of this joint as finished. In making an elbow joint the two ends are to be cut at the proper angle, as indicated by the diagonal line in fig. 5. These angular ends being then heated, are to be brought together accurately, but with a gentle pressure, to avoid raising a burr in the inside. The outer edges may be pinched together, and a plunge in cold water cools and completes the joint. The seam may be strengthened by attaching a thin slip of softened gutta percha round the joint. If a small tube is to be connected to a large one—say at right angles to it—an opening is to be cut in the side of the large tube, sufficient to receive the smaller one—a piece an inch long is then cut from the small tube, the end being formed to a curve to correspond to the line of junction, and this is applied, in a warm state, to the orifice, with gentle pressure, the burr being kept down in the interior by a mandril. The end of the main length of small tube, being warmed, is expanded, and passed over the short junction piece, leaving a good flange all round, as in fig. 6. This is then pressed whilst hot, the edges being wiped down with a hot iron. If the calibre of the tube is large, it will be sufficient to cut a concave opening and convex end only, joining these surfaces by heat. Fig. 7 shows the mode of joining a gutta percha tube to a metal one. The gutta percha is softened in warm water, and stretched over the end of the metal tube, constantly pressing the gutta percha until it cools. This is all that is necessary to ensure a good joint, as the contraction of the gutta percha gives an excellent hold upon the metal.

Fig. 1.

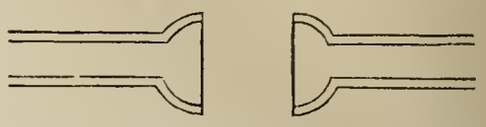


Fig. 2.

Fig. 3.

Fig. 4.

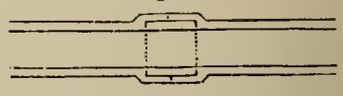


Fig. 5.

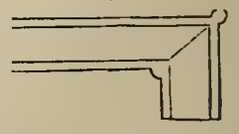


Fig. 6.

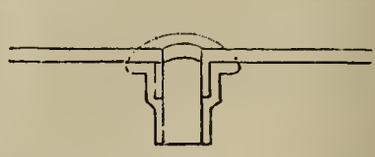


Fig. 7.

The "City of Glasgow," and Glasgow and New York Traffic.—Notwithstanding the so far successful trips of the "City of Glasgow," we are sorry to find that this embryo line of steam communication has fallen through, and the ship has been sold to the firm of Richardson, Brothers, of Liverpool, for the sum of £40,000. She is in future to run between Liverpool and Philadelphia, and her late voyage from the Clyde is to be considered the last she will make from a Scottish port. Her short career has still been sufficient to show the clear-sightedness of her builders, Messrs. Tod & M'Gregor, who have, in her, fully demonstrated the feasibility of the establishment of the line for which she was designed. Her withdrawal arises, not from a want of public support, but from apathy on the part of capitalists, to whom projectors must look for carrying out a brilliant scheme on a scale of corresponding extent. However well the "City" might have answered in herself, she would have been helpless alone. To keep up a regular correspondence, additional vessels would, of course, be required. This extension not being obtainable amongst the Clyde merchants, has compelled a look-out elsewhere. Liverpool has stepped in for the purpose, and the conveying powers of the new

Liverpool and Philadelphia line are to be forthwith increased by a still larger screw-ship, the keel of which has been laid by the builders of the "City." It has since been whispered, that the promoters of the Cunard line have themselves in view the establishment of a line of screw steamers from the Clyde to New York, so that although the "City of Glasgow" must henceforth rank as a Liverpool ship, we may yet see a squadron of Atlantic steamers of our own.

A Method of obtaining Pure Iron.—At the recent meeting of the British Association, Mr. J. P. Joule, the well-known electrician, read a paper "on some amalgams," in which he pointed out the following easy method of obtaining iron in a state of purity. A solution of sulphate of iron is decomposed by one or more couples of Daniell's battery, the negative electrode consisting of mercury, and the positive of a plate of iron. After a few hours a semi-fluid amalgam of iron is formed, which after being left alone for a few days, resolves itself into the constituent metals. Mr. Joule remarked, that in the further prosecution of his researches, he had found that when the amalgams were subjected to great pressure, the mercury mechanically combined with them was expelled, leaving definite compounds of mercury and the respective metals.

Dixon's Ventilator—Infringement of Design.—This useful contrivance, of which an engraving will be found at page 87 of our second volume, has just furnished an example of the successful resistance of a registree against a gross piratical imitation. A Mr. Bessel was the defendant in the case, which came before Mr. Alderman Wilson at Guildhall, during the past month. The imitation complained of, was almost an absolute copy of the original—the difference being, that a metal frame was substituted for a wooden one, and the actuating screw for opening and closing the moveable valve pane, was curved instead of straight, as made by Mr. Dixon. The infringement was fully made out, and a fine of £30 each, for the offences of making and selling a ventilator, after notice from the proprietor of the Design, with £10 additional in the shape of costs, was inflicted. This example may perhaps have some effect in putting a stop to the too common practice of illegally copying designs. Mr. Alderman Wilson, in giving judgment, took the opportunity of complimenting Mr. Dixon on the ingenuity of his invention.

Improved Sugar Machinery for Demerara.—Messrs. Neilson, of Hyde Park Foundry, Glasgow, have just completed and shipped off to Demerara, a splendid set of sugar machinery, embodying many novelties and improvements. The machinery comprises two steam-engines, a set of pumps and exhausting fan, a cane mill, and a vacuum boiler for evaporating the juice. The steam-engine working the pumps is of the direct action class, nearly all of wrought-iron. Its shaft is formed with three cranks, for working the exhaust pumps, the whole being combined in one machine, and exhibiting one of the best specimens of arrangement and finish that we have ever seen. There is little novelty in the cane mill, except as far as its immense size is concerned. It weighs 40 tons without its driving gearing, therefore some idea may be formed of the ponderous nature of the crushing cylinders. There is, however, one practical point of importance in this part of the machinery which is certain to be imitated in all future mills of this class. This is in the gearing: instead of driving the rollers by a small pinion, gearing with an immense spur-wheel, Messrs. Neilson have substituted double gear, so that smaller wheels are used, the speed being diminished at twice instead of once, as usual. The effect of this is to secure great steadiness, and if a wheel does fail, the great expense of reproducing a vast spur wheel is avoided. It is in the vacuum pan, however, that the chief improvements are introduced, the arrangement being the invention of Mr. Beanes, Messrs. Neilsons' representative in the Havana. Its design resembles a circular praying temple, standing on a base 20 feet diameter, from which spring six fluted Doric columns to a height of 16 feet. These are surmounted by a circular entablature, cast hollow to receive the copper condensing tubes for the vapour arising from the boiling juice. Within the outer circle of columns is another set of four columns, supporting the pan, which, with its cover, forms the apex or cupola of the whole. Beneath this cover, and between the two circles of pillars, is a railed platform for the attendants, who are thus placed in direct charge of the whole of the governing apparatus. In Cuba, where this machinery is to be erected, it is impossible to procure a due supply of condensing water. Mr. Beanes has therefore, in this design, had this drawback under especial consideration, and has so contrived his plans that the vapour generated by the boiling juice furnishes the water necessary for the operations. The vapour is conducted from the top of the pan, by four copper tubes, into the tubular entablature, and thence through an immense series of vertical tubes in the outer columns, which are kept cool by a current of cold air drawn from a deep pit by the exhaust fan. There are several other details of importance which we cannot describe here, but we saw enough of the action of the whole, when in operation at the Hyde Park Works, to deserve the remark, that the highest credit is due alike to Mr. Beanes, the inventor, as to Mr. Walter Neilson, the practical worker out of the plans.

Crayon Daguerreotypes.—Mr. Mayall, the Daguerreotype artist of the Strand, has addressed the following letter to the editor of the *Athenæum*:—"I beg through your valuable columns to make known to daguerrian artists and amateurs the following process,—entitled, as above, Crayon Daguerreotypes. I do this the more willingly from the fact that an attempt is making to patent a process for producing a similar effect, and as I am a decided enemy to patenting anything in connection with so interesting a discovery, I hope this communication will set the matter at rest. 1st. Take a daguerreotype image on a prepared plate, as usual, taking care to mark the end of the plate on which the head is produced. When taken, and before mercurializing, remove the plate from the holder, and place on it a plate of glass prepared as follows. 2d. Cut a piece of thin plate glass of the same size as the daguerreotype plate; gum upon one side of it a thin oval piece of blackened zinc, the centre of the oval to coincide with the centre of the image upon the plate. Having carefully placed the glass, thus prepared, with the centre of the zinc disc upon the centre of the image, expose the whole to daylight for 20 seconds. The action of the light will obliterate every trace of image from every part of the plate, except that which is covered with the blackened zinc,—and also, from the thickness of the glass, the action will be refracted under the edges of the zinc disc, and will soften into the dark parts. Mercurialize the plate as usual; the image will be found with a halo of light around it, gradually softening into the background, that will at once add a new charm to these interesting productions. By grinding the glass on which the disc is fixed, and by altering the shape and size of the disc, a variety of effects may be produced, which every ingenious operator can suggest for himself."

A Poor Man's Tale of a Patent.—In a recent number of Dickens's "Household Words," we find the following history of the distresses of a poor patentee. The experienced in these matters will doubtless bear testimony to his truthful delineation of the treatment received from the government clerks:—"After a deal of trouble I found out a Master in Southampton-buildings, Chancery-lane, where I made the declaration, and paid 18d. I was told to take the declaration and petition to the Home-office, in Whitehall, where I left it to be signed by the Home Secretary (after I had found the office out), and where I paid £2 2s. 6d. In six days he signed it, and I was told to take it to the Attorney-General's chambers, and leave it there for a report. I did so, and paid £4 4s. Note.—Nobody, all through, ever thankful for their money, but all uncivil. My lodging at Thomas Joy's was now hired for another week, whereof five days were gone. The Attorney-General made what they called a report-of-course (my invention being, as William Butcher had delivered before starting, unopposed), and I was sent back with it to the Home office. They made a copy of it, which was called a warrant. For this warrant I paid £7 13s. 6d. It was sent to the Queen, to sign. The Queen sent it back signed. The Home Secretary signed it again. The gentleman throwed it at me when I called, and said, 'Now take it to the Patent-office in Lincoln's-inn.' I was then in my third week at Thomas Joy's, living very sparing, on account of fees. I found myself losing heart. At the Patent office in Lincoln's-inn, they made 'a draught of the Queen's bill' of my invention, and a 'docket of the bill.' I paid £5 10s. 6d. for this. They 'engrossed two copies of the bill—one for the Signet-office and one for the Privy Seal-office.' I paid £1 7s. 6d. for this. Stamp duty over and above, £3. The engrossing-clerk of the same office engrossed the Queen's bill for signature. I paid him £1 1s. Stamp duty again, £1 10s. I was next to take the Queen's bill to the Attorney-General again, and get it signed again. I took it and paid £5 more. I fetched it away and took it to the Home Secretary again. He sent it to the Queen again. She signed it again. I paid £7 13s. 6d. more for this. I had been over a month at Thomas Joy's. I was quite wore out patience and pocket. Thomas Joy delivered all this, as it went on, to William Butcher. William Butcher delivered it again to three Birmingham parlours, from which it got to all the other parlours, and was took, as I have been told since, right through all the shops in the north of England. Note.—William Butcher delivered at his parlour in a speech, that it was a patent way of making chartists. But I hadn't nigh done yet. The Queen's bill was to be took to the Signet-office in Somerset-house, Strand—where the stamp shop is. The Clerk of the Signet made 'a Signet-bill for the Lord Keeper of the Privy Seal.' I paid him £4 7s. The Clerk of the Lord Keeper of the Privy Seal made 'a Privy Seal bill for the Lord Chancellor.' I paid him £4 2s. The Privy Seal bill was handed over to the Clerk of the Patents, who engrossed the aforesaid. I paid him £5 17s. 8d.; at the same time I paid stamp duty for the patent, in one lump, £30. I next paid him for 'boxes for the patent,' 9s. 6d. Note.—Thos. Joy would have made the same at a profit for 1s. 6d. I next paid 'fees to the Deputy, the Lord Chancellor's Purse-bearer,' £2 2s. I next paid 'fees to the Clerk of the Hanaper,' £7 13s. I next paid 'fees to the Deputy-clerk of the Hanaper,' 10s. I next paid to the Lord Chancellor again, £1 11s. 6d. Last of all, I paid 'fees to the Deputy Sealer and Deputy Chaff Wax,' 10s. 6d. I had lodged at Thomas Joy's over six weeks, and the unopposed patent for my invention, for England only, had cost me £96 7s. 8d. If I had taken it out for the United Kingdom, it would have cost me more than £300."

ENGLISH PATENTS.

Sealed from 26th September, to 17th October, 1850.

Henry Houldsworth, Coltness House, Lanark, North Britain, iron-master,—"Improvements in the manufacture of iron and other metals."—September 26th.

Alfred Vincent Newton, Chancery-lane, mechanical draughtsman,—"Improvements in dycing yarn, &c., in manufacturing certain woven fabrics."—(Communication.)—26th.

James Hamilton, London, engineer,—"Improvements in machinery for sawing, boring, and shaping wood."—28th.

Charles Harratt, Royal Exchange-buildings, London, merchant,—"Improvements in rolling iron."—28th.

Joseph Burch, Craig Works, Chester, printer,—"Improvements in printing terry and pile carpets, woollen, silk, and other materials."—28th.

Joseph Crossley, Halifax, carpet manufacturer; George Collier, of the same place, mechanic; and James Hudson, Littleborough, printer,—"Improvements in printing yarns for, and in weaving carpets and other fabrics."—28th.

Cyprien-Theodore Tissercau, Paris, France, gentleman,—"Certain improvements in hydraulic clocks."—October 3d.

Jean-Pierre-Paul Amberger, Paris, France, civil engineer,—"Certain improvements in the application of magnetic power for moving and stopping carriages, for giving adherence to wheels upon rails, and also for transmitting motion."—3d.

William Tudor Mabley, Manchester, patent agent,—"Certain improvements in the manufacture of soap."—(Being a communication.)—3d.

William Boggett, St. Martin's-lane, Middlesex, gentleman, and William Smith, Margaret-street, in the said county, engineer,—"Improvements in producing and applying heat, and in engines to be worked by steam or other elastic fluid, which engines are also applicable as pumps."—3d.

Julian Bernard, Buchanan-street, Glasgow, artist,—"Improvements in pneumatic springs, buffers, pumps, and stuffing-boxes."—3d.

Charles Bury, Salford, Lancaster, manager,—"Certain improvements in machinery or

apparatus for preparing and spinning, doubling or twisting silk waste, cotton, wool, flax, or other fibrous substances."—10th.

Charles Bury, Salford, Lancaster, manager,—"Certain improvements in machinery or apparatus for cleaning, spinning, doubling, and throwing raw silk."—10th.

Robert Beart, Godmanchester,—"Improvements lu the mauufacture of bricks and tiles."—10th.

John Scott Russell, Great George-street, Westminster, engineer,—"Improvements in the construction of ships or vessels propelled by paddle-wheels, with a view to better arming the same."—10th.

William Wood, Over-Darwin, Lancashire, carpet manufacturer,—"Improvements in the manufacture of carpets and other fabrics."—10th.

William Henry Ritchie, Keunington, Surrey, gentleman,—"Certain improvements in machinery for preparing and carding fibrous substances."—(Communication.)—10th.

William Edward Newton, Chancery-lane, engineer,—"Improvements in manufacturing yarns."—(Communication.)—10th.

James Hamilton Brown, of the Reform Club, Pall-Mall, Esq.,—"Improvements in the separation and disinfection of fecal matters, and in the apparatus employed therein."—(Communication.)—10th.

William Francis Fernihough, London, engineer,—"Improvements in locomotive and other steam engines, and improvements in obtaining motive power."—10th.

Whiting Hayden, of Windham, Connecticut, United States of America,—"An improved regulator, or apparatus for regulating the draught of the sliver on the machine, termed the 'drawing frame.'"—10th.

Ardolf Frederick Gurlt, Manchester, gentleman,—"An improved method of extracting silver from argentiferous minerals."—10th.

George Michiels, London, gentleman,—"Improvements in treating and preparing potatoes for seed."—(Being a communication.)—17th.

John Fowler, jun., Melksham, Wilts, engineer,—"Improvements in steam engines in raising and forcing fluids in irrigating and draining land, and in machinery for cutting wood for drain pipes and other uses."—17th.

Daniel Trowers Shears, Bankside, Surrey, copper merchant,—"Improvements in the manufacture and refining of sugar."—(Being a communication.)—17th.

John Robert Johnson, Crawford-street, chemist,—"Improvements in fixing colours on fabrics made of cotton and other fibre."—(Being a communication.)—17th.

James Henry Baddeley, Shelton, Stafford, engineer and designer,—"Improvements in the manufacture of ornamental articles of earthenware."—17th.

Thomas Richards Harding, Lille, France, manufacturer,—"Improvements in machinery for heckling and carding flax in machinery, for combing and drawing wool and other fibrous materials, and in machinery for making parts of such machines, and for a new arrangement of the steam engine for driving flax and woollen mills, which arrangement is also applicable to other purposes where motive power is required."—17th.

Henry Bernoulli Barlow, Manchester, consulting engineer,—"Improvements in spinning cotton and other fibrous materials."—17th.

James Henry Williams, Birmingham, manufacturer,—"Certain improvements in the manufacture of buttons."—17th.

James Young, Manchester, manufacturing chemist,—"Improvements in the treatment of certain bituminous mineral substances, and in obtaining products therefrom."—17th.

SCOTCH PATENTS.

Sealed from 22d September, to 22d October, 1850.

William Benson Stones, Golden-square, Middlesex, Manchester warehouseman,—"Improvements in treating peat and other carbonaceous matters, so as to obtain products therefrom."—23d September.

Thomas Coats, Ferguslie, Paisley, Renfrewshire, thread manufacturer,—"Certain improvements in turning, cutting, and shaping wood, and other materials."—23d.

Evan Leigh, Miles Platting, near Manchester,—"Certain improvements in machinery or apparatus for preparing and spinning cotton, and other fibrous substances."—25th.

Jasper Wheeler Rogers, Dublin, civil engineer,—"Certain improvements in the preparation of peat, and in the manufacture of the same into fuel and charcoal."—30th.

Jesse Bridgman, London, gentleman,—"Certain improvements in separating the fatty and oily from the membraneous portions of animal and vegetable substances."—30th.

Richard Prosser, Birmingham, Warwickshire, civil engineer,—"Improvements in machinery and apparatus for manufacturing metal tubes, which improvements in machinery are in part applicable for other purposes, where it is required; also for improvements in the mode of applying metal tubes in steam boilers or other vessels, and in the mode of clearing out the tubes of steam boilers, and in the mode of feeding or supplying steam boilers with water."—1st October.

William Keates, Liverpool, Lancaster, merchant,—"Improvements in machinery for manufacturing rollers and cylinders for calico printing, and other purposes."—4th.

James Young, Manchester, Lancaster, manufacturing chemist,—"Certain improvements in the treatment of certain bituminous mineral substances, and in obtaining products therefrom."—7th.

Alfred Vincent Newton, 66 Chancery Lane, Middlesex, mechanical draughtsman,—"Improvements in dyeing yarn, and in manufacturing certain woven fabrics."—(Communication.)—8th.

William Tudor Mabley, Manchester, Lancaster,—"Certain improvements in the manufacture of soap."—(Communication.)—10th.

Cuthbert Dimsdale, Newcastle-upon-Tyne, dentist,—"Improvements in the manufacture of artificial palates and gums, and in the mode of setting or fixing natural and artificial teeth."—11th.

John Beattie, Liverpool, Lancaster, engineer,—"Certain improvements in steering vessels."—14th.

John Grant, Hyde Park-street, Middlesex,—Improvements in heating and regulating temperature."—14th.

Etienne Joseph Hanon Valcke, Belgium, miller,—"Improvements in grinding."—14th.

John Mercer, Oakenshaw, within Clayston le Moors, Lancaster, gentleman,—"Improvements in the preparation of cotton, and other fabrics and fibrous materials."—14th.

William Erskine Cochrane, Cambridge Terrace, Regent's Park, Middlesex, and Henry Francis, Princes-street, Rotherhithe,—"Improvements in propelling, steering, and ballasting vessels, in the pistons of steam-engines, in fire bars of furnaces, and in sleepers of railways."—14th.

Alexander Dixon, Ahercorn Foundry, Paisley,—"Improvements in moulding iron, and other metals."—16th.

William Palmer, Sutton-street, Clerkenwell, manufacturer,—"Improvements in the manufacture of candles and wicks."—16th.

Eugene Ablon, Panton-street, Haymarket, Middlesex,—"Improvements in increasing the draft in chimneys of locomotive and other engines."—16th.

William Henry Green, Basinghall-street, London, gentleman,—"Improvements in the preparation of peat, and in the mode of converting and applying some of the products derived therefrom to the preservation of substances which are subject to decay."—12th.

Charles Bury, Salford, Lancaster, manager,—"Certain improvements in machinery or apparatus for cleaning, spinning, douhling, and throwing raw silk."—18th.

William Edward Newton, 66 Chancery Lane, Middlesex, civil engineer,—"Improvements in manufacturing yarn."—(Communication.)—18th.

John Percy, Birmingham, Warwick, M.D., and Henry Wiggin, Birmingham,—"A new metallic alloy, or new metallic alloys."—21st.

IRISH PATENTS.

Sealed from 21st September, to 19th October, 1850.

Peter William Barlow, Blackheath, Kent, civil engineer, and William Henry Barlow, Derby, civil engineer,—"Improvements in the permanent ways of railways."—5th Oct.

Amadee Francois Remond, Birmingham,—"Improvements in machinery for folding envelopes, and in the manufacture of envelopes."—5th.

William Benson Stones, Golden-square, Middlesex, Manchester warehouseman,—"Improvements in treating peat and other carbonaceous and ligneous matters, so as to obtain products therefrom."—(Communication.)—7th.

William Cox, Manchester, Lancaster, cigar merchant,—"Certain improvements in machinery, or apparatus for manufacturing ærated waters, or other such liquids."—16th.

Edward Highton, Clarence-villa, Regent's-park, Middlesex, engineer,—"Improvements in electric telegraphs, and in making telegraphic communications."—17th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 18th September, to 15th October, 1850.

Sept. 18th,	2443.	Joseph Guise, Clerkenwell-green,—"Catoptric deflector and brackets for a gas burner."
—	2444.	Richard Bright, Burton-street, Broad-street,—"Portable safety carriage lamp."
19th,	2445.	A. & W. Smith & Co., Paisley,—"Centrifugal agitating churn."
20th,	2446.	A. Keep and W. Watkin, Stourbridge,—"Parts of a vice."
21st,	2447.	F. A. Frinneby, Cannon-street,—"Oval brush."
—	2448.	H. J. and D. Nicoll, Regent-street,—"Inner lining or waddiug for garments."
—	2449.	S. Harrison, Stanhope-street, Clare-market,—"Ventilator."
24th,	2450.	J. G. Taylor, Great St. Thomas Apostle,—"Safety mount for fastening."
25th,	2451.	W. J. Epps, Maidstone,—"Sulpburator."
26th,	2452.	George Boulton, Great Dover-street, Borough,—"Globular shield pin."
—	2453.	William Cutler, St. James's-street,—"The duplexa coat."
—	2454.	Joseph Morris and Sons, Astwood, Redditch,—"Needle-case."
28th,	2455.	Hurst & Reynolds, Birmingham,—"Improved fastening for stays, and other articles of dress."
Oct. 1st, No.	2456.	Thomas Thomson, Commander, Royal Navy,—"Safety-plug for boats and vessels."
—	2457.	George Aldred, Primrose-street, Bishopsgate,—"Plate mortice nut for a looking-glass."
—	2458.	Walter Raymond, Dalston,—"Life-raft."
2d,	2459.	Frederick Clowes, Birmingham,—"Self-adjusting vertical brace."
—	2460.	Samuel Augustus Hayes, Straud,—"Apparatus for fractures of the lower extremities."
3d,	2461.	Thomas Key. Charing-cross,—"Regimental cased clarionet."
4th,	2462.	Clayton, Shuttleworth, & Co., Stamp End Works, Lincoln,—"Combined threshing, shaking, and riddling machine."
—	2463.	H. Kilby and W. Harris, Cheltenham,—"Portable hot-house."
—	2464.	John George Taylor, Great St. Thomas Apostle,—"Self-securing spring for pins, brooches, and ornaments."
—	2465.	Allen and Moore, Birmingham,—"Match-box lid."
—	2466.	Mortiboy and Herbert, Newman-street, Oxford-street,—"Clasp-fastener for bracelets, chains, and other articles of jewellery and dress."
5th,	2467.	John Cartwright, Newton-wood, Chester,—"Steam boiler."
—	2468.	George Harrows, Old Bond-street,—"Railway travelling trunk"—"The Panelasticon."
7th,	2469.	George Boulton, Great Dover-street, Borough,—"Safety pin."
8th,	2470.	Roger Brown, Sheffield,—"Magnetic lightning conductor."
—	2471.	Elkington and Co., Birmingham,—"Fountain."
—	2472.	W. Culverwell, Charlotte-street, Blackfriars-road,—"Portable domestic vapour bath."
—	2473.	Fox, Henderson, and Co., Birmingham; and Spring gardens, London,—"Luffer for a ventilator."
—	2474.	Miall, Marshall, and Co., Ingram-court, Fenchurch-street,—"Duplex flanged pipe joints."
—	2475.	William Chapman, Johnson-street, Clonmel, Tipperary,—"Grain crusher, and regulating feed, for facilitating the grinding of meal and flour."
9th,	2476.	William Lowe, Birmingham,—"Bolt."
10th,	2477.	Louis Dutreilh, Wellington-street, Strand,—"Plantoform, or instrument for measuring the feet of horses for facilitatiug shoeing."
—	2478.	Morris Gardiner, Ashill, near Watton,—"Lever spring-drop."
11th,	2479.	John Gray and Robert Jon Keen, Liverpool,—"Anti-vibration elastic compass disc."
12th,	2480.	John Smith, Uxbridge,—"Revolving sifter."
14th,	2481.	Thomas Smith Freeman, Fenchurch-street,—"Safety pocket for waistcoats."
15th,	2482.	Charles Beinhauer, Hamburg,—"Economical registered stove."

TO READERS AND CORRESPONDENTS.

T. T., Preston.—Our October part was made up when his query was received last month. See Lieutenant-Colonel Reid "On the Law of Storms," Weall, 1846. Also, the Reports of the Proceedings of the British Association, as published annually by the Association. Mr. Osler's (of Birmingham) Anemometrical experiments present a vast amount of valuable information on the subject, and these have been regularly communicated to the British Association.

W. B. J., Manchester.—The drawings, &c., are received.

Who invented PARKER'S WATER-WHEEL?—The Franklin Journal for May, commenting severely upon J. G.'s letter on this subject, which appeared at page 281 of our second volume, has, through some inadvertence, only just reached us. We have not been able to give the remarks, with our correspondent's reply, this month, but shall do so in our December Number.

T. P., New York.—Received, and will be prepared for immediate publication.

The Pamphlets from Apalachicola, U. S., on Dr. Gorrie's process for the artificial production of Ice, have been received.

Mr. SCHIELE, Manchester, will see we have adopted his suggestion.

Dr. FOULIS, Edinburgh.—We regret this communication was received to late for insertion this month.

W. R., (Old Jewry).—We shall be glad of the information as early as possible.

Messrs. SIMPSON and SHIPSTON.—Received—but too late for the present month.

A Reader, Manchester.—We are compelled to postpone replying to his communication until next month.

Mr. RETTIE (Signals).—This letter was received too late for insertion this month.

SELF-ACTING SEWER TRAPS.—We will notice this correspondence.

SAFETY CAGE

AND DETACHING CATCH,

FOR MINE SHAFTS,

Messrs. White & Grant,

Engineers,

GLASGOW.

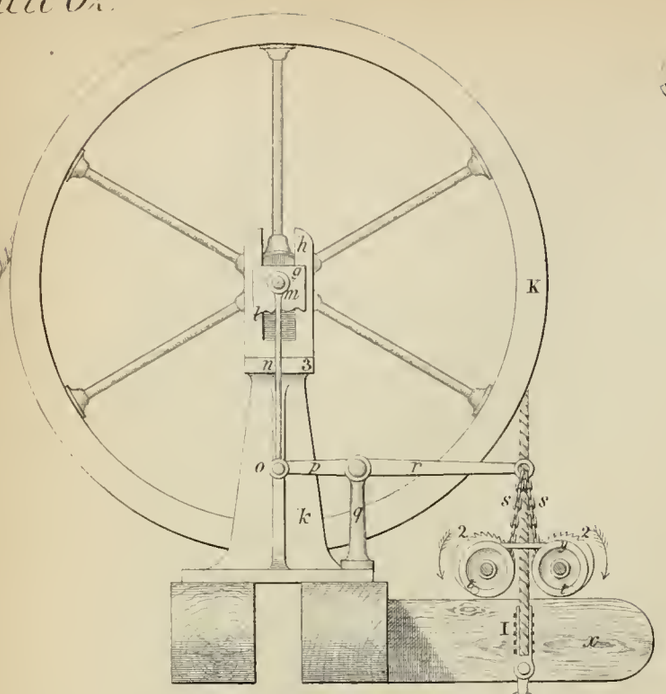


Fig 1.

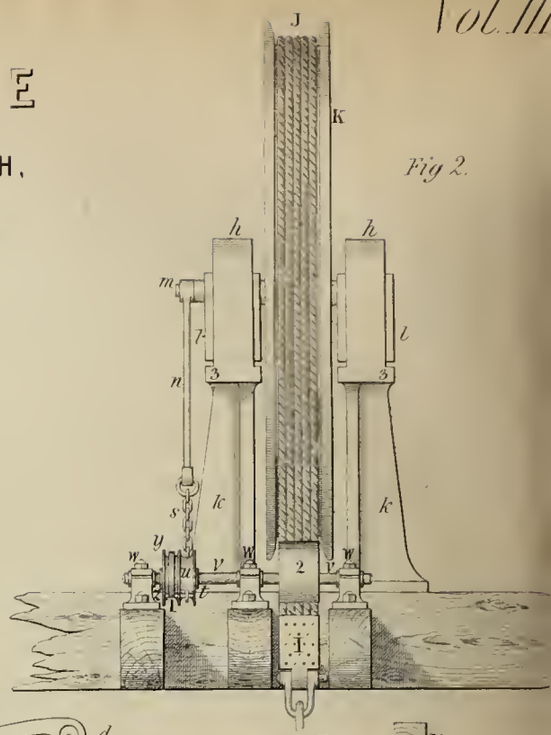


Fig 2.

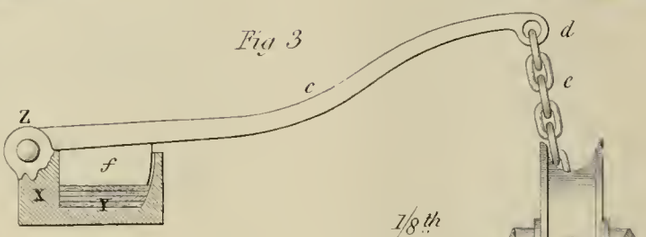


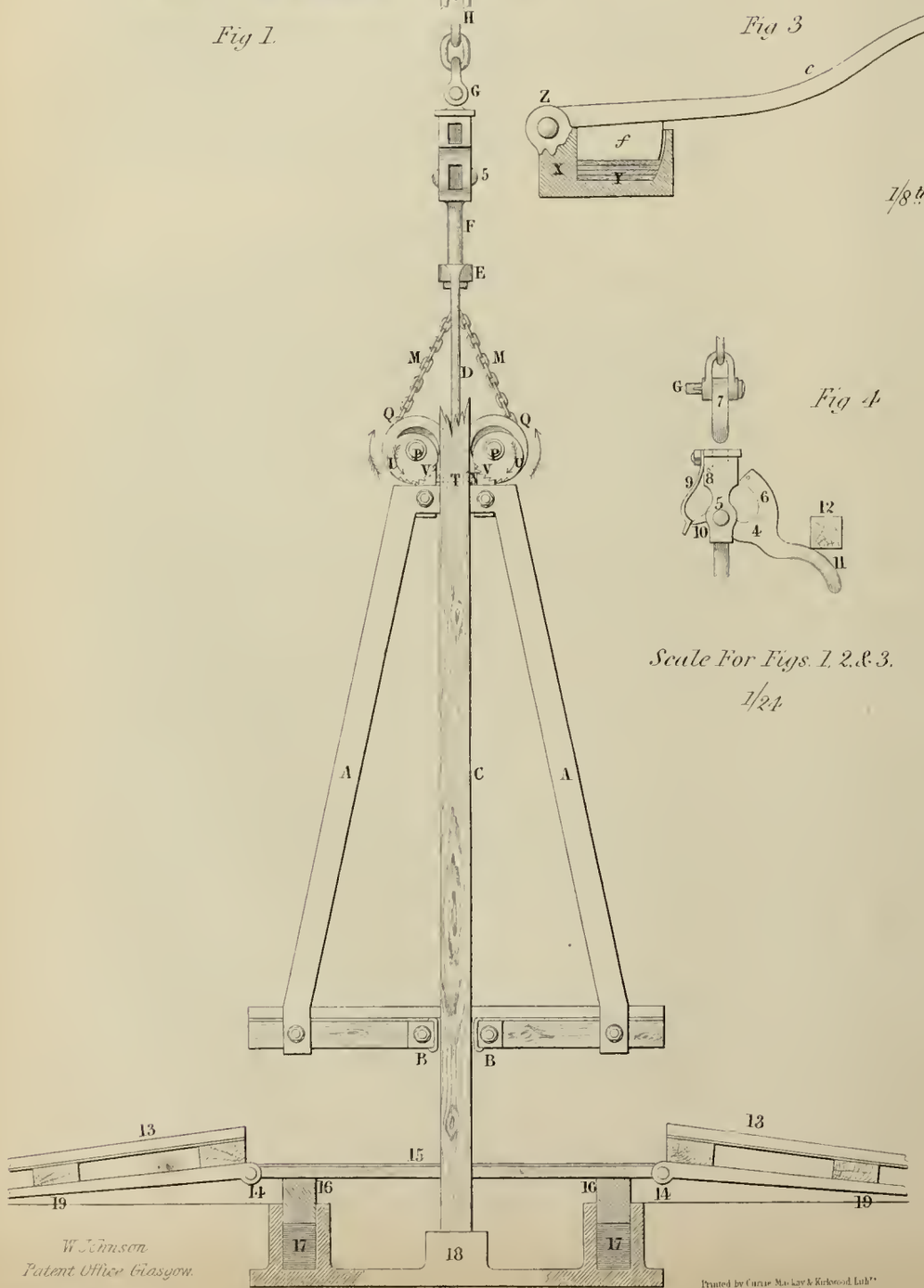
Fig 3

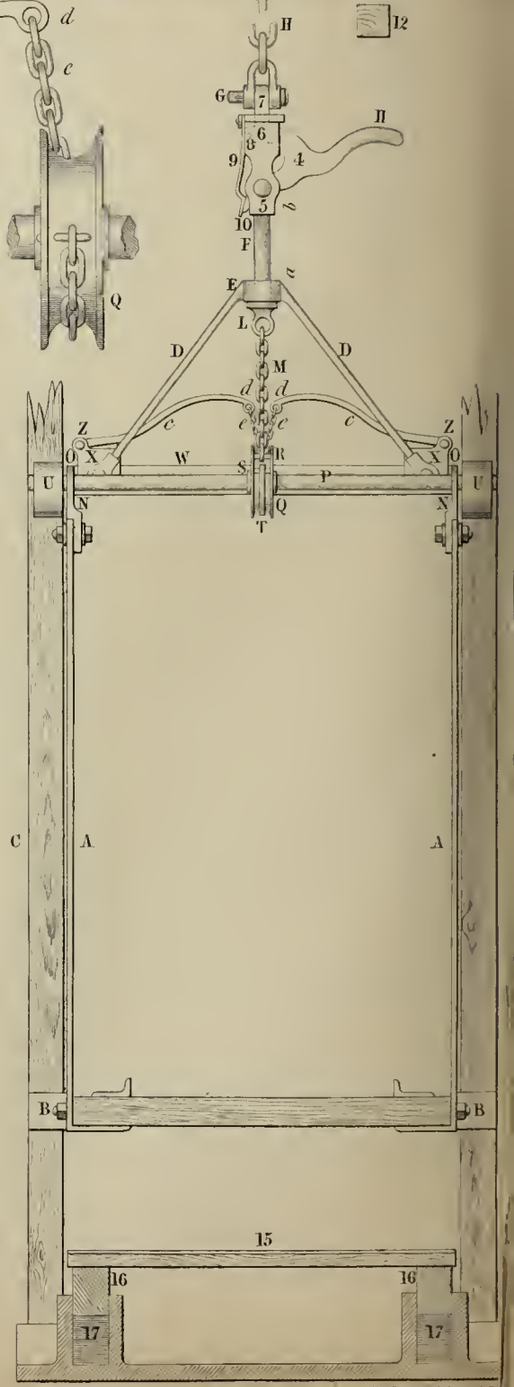
1/8th

Fig 4

Scale For Figs. 1, 2, & 3.

1/24





W. Johnson, Patent Office Glasgow.

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Thos. MacLay & Kirkwood, Sc.

IMPROVEMENTS IN MINE MACHINERY.

WHITE AND GRANT'S SAFETY CAGE AND DISENGAGING CATCH FOR MINE SHAFTS.

Illustrated by Plate 62.

The newspapers are constantly reminding us of the many imperfections of the mechanical details of the miner's machinery—in their records of accidents from the "failure of the rope," and "over-winding"—casualties, which might be completely driven out of existence by a proper attention to the construction and management of the lifting apparatus. A rope breaks, or a cage is over-wound—one or two men are killed—their widows and children go to swell the list of our poor-house inmates—a judicial investigation results—verdict, "accidental death:"—such is, unfortunately enough, too often the case. Some ingenious man is then prompted to expend his talent on an examination into the existing arrangements of the machinery, and to provide a means of remedying the apparent defects. The invention is put in practice, is found too heavy and complicated, gets out of order, and perhaps fails in a case of actual fracture: the colliery owner grows apathetic, the apparatus is thrown aside, and the old system is again pursued. That such a fate will not attend Messrs. White & Grant's invention, if simplicity, cheapness, and efficacy can prevent it, is, we think, pretty fairly evidenced in the engraving which illustrates the present paper.

In Plate 62, we have delineated four several points of improvement introduced by these gentlemen, three of which are devoted to the prevention of rope accidents alone. Fig. 1, represents a side elevation of a cage, or lifting apparatus, with its overhead winding pulley, platform and slides, as fitted with the new safety apparatus. Fig. 2, is a corresponding front view of the same. A, Is the cage built or constructed in the usual manner and fitted with slides, B, for the vertical timber guides, C, by which the cage is accurately guided vertically in its ascent and descent. The links, D, connected at their lower ends to the top of the cage, converge upwards to an eye, at E, which is passed upon the lower end of the vertical link-piece, F, and in this way the cage is suspended from the latter, by the collar at the end. The link-piece, F, is again connected by a link at G, to the chain, H, which is represented in the engraving as broken, in order to economise space, and the upper end of this chain is again linked to the junction plate, I, of the flat winding rope, J, passing over the overhead winding pulley, K, to the winding power. An eye, L, is formed on the extremity of the link-piece, F, to carry the ends of the two safety chains, M, which form the connection between the rope or suspending apparatus, and the stop or safety apparatus, carried on the top of the cage. At N, are two metal brackets bolted to the cross pieces on the top of the cage, one on each side, opposite, and corresponding to each other. Each of these brackets has two solid eye bearings, O, to carry the ends of the horizontal parallel shafts P, each of which has keyed upon it at its longitudinal centre a grooved chain or rope pulley, Q. The lower ends of the two safety chains, M, pass partially round these pulleys, and are connected to the peripheries of the latter, by transverse pins, at R, passed through the rims. Near these pins two other similar pins, S, are similarly attached to the peripheries of the pulleys, and a single ring or endless band of vulcanised India rubber, is passed upon these pins, so that when the pulleys are turned outwards in the direction of the arrows, the ring being extended beneath the pulleys from pin to pin, the strain causes it to assume the form of a duplex band, as at T. Or, instead of this ring, a single band may be used, an eye being formed on each end of it, for attaching it to the two pins. The shafts, P, extend beyond their bearing brackets, N, sufficiently far to receive the eccentric clipping, or stay pulleys, U. There are four of these pulleys, one being on each end of each shaft, one of the cage guides, C, coming between each pair. Each pulley is serrated or toothed on a portion of its periphery, as at V, in figure 1, in order that when turned inwards, in the direction of the arrows marked upon them, so as to bring their eccentric portions towards the guides, the serrations, at V, may bear on each side of the guides, and afford a hold to stay the descent of the cage. As delineated in the plate, the cage is supposed to be in action, and has just arrived above the platform of the shaft, or is about to descend below it. The winding rope and connections throughout, are further supposed to be in proper working order, and the tension upon these parts is consequently acting so as to retain the safety apparatus out of connection with the guides. The link, F, which supports the cage, is inserted loosely into the eye, E, in such manner, that it may, when necessary, slide through the latter from *a* to *b*. By this arrangement, when the tension occasioned by the weight of the cage comes upon the winding rope, the latter, first of all, hauls up the safety chains, M, which thus turn the pulleys Q, partially round, as indicated by the arrows. This action extends the elastic band spring, T, and eases off the two eccentric pulleys, U, so as to free them from contact with the cage guides. When this is accomplished, the collar at the lower end of the link, F, comes in contact with the under side of the eye, E, and bears up the cage. In this way, so long as the rope and suspending connections remain whole, the resulting tension upon the safety chains keeps the stop apparatus clear of the guides, and allows the cage to move freely up and down; but should the rope or links break, the reacting elasticity of the spring, T, will turn round the shafts, P, in the direction of the arrows on the pulleys U, in figure 1, when the serrated portions of the peripheries of these pulleys will come in contact with the opposite surfaces of the guides, C. The grasp thus occasioned upon the guides, holds up the cage until the rope is re-adjusted, when the upward tension of the latter will again put the safety apparatus out of gear. It is to be observed that the action of the pulleys, U, is such, that the greater the weight upon the cage, the more secure will be the hold of the pulleys upon the guides, as the downward pressure causes the serrations to bear inwards upon the guides.

In fig. 2 is represented a second arrangement of a spring apparatus for actuating the clipping or holding pulleys of the cage, and the same movement is also delineated on a larger scale in fig. 3, where one lever only is shown, detached. A central cross bar, W, has fastened to it, near each end, a cast-iron box, X, containing layers of vulcanized India-rubber, Y, to act as a spring, or, instead of India-rubber, any other suitable elastic material may be used. Each box has an eye-piece, Z, formed upon it to receive the eyes on the outer ends of the spring levers, *c*, the opposite ends of which are linked at *d*, to the chains, *e*, one end of each of which passes round one of the pulleys, Q, the shafts of which are, in the detail, fig. 3, supposed to be broken away. Each lever, *c*, has formed upon it a projecting piece, *f*, to fit into the narrow open-topped boxes, Y, and press upon the surface of the contained spring, and thus the reaction of these springs constantly tends to elevate the levers, drawing up the chains, *e*, and partially turning the pulleys, Q. The shafts of these pulleys carry eccentric clipping pulleys, as already described in reference to figs. 1 and 2, so that this upward action of the levers tends to cause the pulleys to bite upon the guides and sustain the cage when the tension of the safety chains, M, which are also attached to the pulleys, Q, no longer opposes the springs, on the fracture of the rope.

Another modification of these improvements in the machinery or apparatus to be used for the prevention of accidents from the breaking of the winding-rope, and also applicable for the prevention of what is technically known as "over-winding," that is, the elevation of the cage or lift apparatus so high up as to come in contact with the overhead gear, and occasion serious accidents to life and property, is also to be described in reference to figs. 1 and 2. The overhead winding pulley, K, is carried on a shaft resting in movable or sliding brasses, *g*, which have liberty to move vertically up or down in the slotted heads, *h*, of the bearing pedestals, *k*. The bottom of each of these slotted guides is filled in with layers of some elastic material, as India-rubber; which material is retained in position by the external flanges, *l*, of the sliding brasses,

shown as broken away in fig. 1, in order to exhibit the elastic material behind. The shaft of the winding pulley projects slightly on one side, at *m*, and to this projection an eye of a short link-rod, *n*, is loosely jointed. The lower end of this link is connected at *o* to the short end of the lever, *p*, working loose on a fixed stud-centre in the top of the pillar or standard, *q*. The opposite end, *r*, of this lever is connected to two short chains, *s*, the contrary ends of which are fast to transverse pins, *t*, in the peripheries of the small pulleys, *u*. These pulleys, *u*, are keyed on the short horizontal shafts, *v*, supported in the bearings, *w*, on the timber frame, *x*, carrying the overhead gear. Alongside each of the chain pulleys, *u*, a second pulley, *y*, is fastened upon the shafts, *v*. In each of these pulleys, *y*, a pin, *z*, is fastened, to receive the opposite ends of an elastic band, 1, passing across from one pulley to the other on the upper side. Each of the shafts also has fast upon it a serrated eccentric clipping pulley, 2, formed like the pulleys, U, already described. The winding rope, J, passes between these clipping pulleys, and the elastic tension of the band, 1, has a constant tendency to cause them to nip and sustain the rope between them. During the action of winding, the tension of the winding rope in passing over the pulley, K, causes the shaft of the latter to press upon the elastic material in the slotted guides, *h*, of the bearing pedestals, through the sliding brasses, *g*, which thus descend as the weight comes on the pulley, until the bottom of the flanges, *l*, rests upon the projections, 3, which thus support the weight of the load. This descent of the shaft, acting through the link, *n*, elevates the end, *r*, of the lever, and draws up the two chains, *s*, turning the shafts, *v*, outwards in the direction of the arrows, so as to ease off the pulleys, 2, from contact with the rope.

Should the rope fail, so as to relieve the winding pulley, K, from the downward pressure, the reaction of the elastic material beneath the pulley shaft will cause the shaft and pulley to reascend, drawing up the link, *n*, which thus allows the chains, *s*, to slacken, when the elastic band, 1, reverses the pulleys, 2, causing them to nip the winding rope and sustain the cage. This latter arrangement of a safety apparatus is obviously applicable for the prevention of the accidental falling of the cage, only when the failure of the rope takes place at or above the line of the shafts, *v*; but in cases of "over-winding," it answers the same purpose as the previously described plan, in preventing the cage from falling when the latter is detached from the winding rope by the action of the disengaging catch.

This movement is delineated in fig. 2, and it is also shown detached, with the hook open, in fig. 4. The link, F, in place of being directly connected to the suspending chain, H, is attached, through the medium of the catch, 4, which turns on a stud centre at 5, fast in the link, F. The upper portion of this catch is formed with a species of flat hook at 6, which enters a slot in the link, F, passing through the loose link, 7, on the stud of the lowest link, G, of the chain, H. The pull of the rope thus comes upon the hook, 6, which is kept from accidental disengagement by a slight wooden pin, 8, passed through the link, and through a hole in the end of the hook. As an additional holder, a blade-spring, 9, is attached to the side of the link, F, and presses upon a projecting tail, 10, of the catch. If at any time the cage should be overwound, the tail, 11, of the disengaging catch comes in contact with a stop-piece, 12, set at the proper height to come into action before the cage arrives at the winding pulley. When this occurs, the pressure of the stop on the tail, 11, turns the catch on its centre, 5, breaking out the wooden pin, 8, and releases the link, 7, from the hook, 6; each or either of the stop actions for holding the cage then comes into action as already described, and the cage remains suspended, whilst the rope and chain may pass over the winding pulley without causing any damage.

Another branch of improvement refers to the discharging platforms of mine shafts. These are also delineated in figs. 1 and 2. The inclined stages or platforms, 13, for the conveyance of the waggons to and from the cage, are jointed at 14, to the edges of the discharging platform or stage, 15. The lower surface of this platform has upon it, four projections or pistons, 16, which are fitted to work vertically in cylinders, 17, on the bottom-plate, 18. Each of these cylinders has in it, a series of layers of India-rubber, so that when the waggons or corves are run on or off the platform, they afford an elastic support to receive the weight; the vertical movement of the platform, 15, being allowed for by the joints, 14, and the inclined stages, 13, having liberty to slide at 19. It is evident that this arrangement of elastic supports is applicable to various other similar purposes, where it is an object to mitigate the effects of concussions.

Lastly, it is proposed to make the trap-doors, in the workings of mines, completely automatic, so as to dispense with the employment of trappers. Instead of employing a boy to attend to the opening and closing of the trap-doors as the miners pass through, Messrs. White & Grant's arrangement provides that the passage of the miners shall effect the opening and closing by a self-acting apparatus. A weight is hung to a cord, passing over a vertical pulley, supported by a bracket in the line of the plane of the door when closed. From this pulley the cord passes between two horizontal pulleys to the top edge of the door where it is attached. On each side of the door a curved spring, of flat metal, is fitted with slots at each end, to slide upon fixed studs in the door; so that when the miners' corves or waggons are pushed up against the closed door, they will come in contact with one or other of the springs, and through them, push open the door, without much concussion. When the waggon has passed through, the weight, in falling, acts over the pulleys, and draws the door again to its central closed position. In this way the constant personal attendance of a boy at the door is dispensed with, as the opening may be effected in each direction by the object passing through, whilst the closing is always effected with certainty by the descent of the weight. It is obvious that this arrangement may be applied to all the doors in a mine which it is necessary to keep carefully closed, except at the moment of the passage of the men through them.

This arrangement of self-acting trap-doors is now being introduced into some extensive collieries in the neighbourhood of Glasgow. The adoption of the plan will effect very considerable economy, besides doing away with a branch of employment which is essentially inhuman and degrading.

ON A METHOD OF COOLING THE AIR OF ROOMS IN TROPICAL CLIMATES.*

By Professor Piazzi Smyth, Astronomer Royal for Scotland.

Before the form of the apparatus can be arranged, a necessary preliminary is to decide on the most proper degree of compression to be worked to; especially to ascertain whether the force of the compressed air may not be usefully employed in assisting to compress more air; the apparent advantage being then, that the mechanical power consumed would be little more than just sufficient to overcome the friction of the machine, and make up for leakage; the power employed for the compression of the air being all got back again on its expansion, and this great economy of force greatly over-balancing the attendant disadvantage of increased complexity in the apparatus.

But however specious this application may appear, it fails altogether in practice, for several reasons: first, the difference between the perfect expansive action of the air undergoing compression in the pump-barrel, and the imperfect expansive action of the same air in the expanding working-barrel. In order to insure any effect at all, a considerable degree of compression must be employed, or the force of the expanding air will not be equal to the friction of the additional piston, and other apparatus required for its introduction. The action of compressed air would be very similar to that of high-pressure steam, and that not being a profitable source of power, until the tension has reached several atmospheres, the air should not be employed at less. But then the difficulty is experienced, that the air having been forced into the cooler by the pump, and deprived then of its heat of compression, occupies less space than before; and this deficiency increases with the compression, as does also

* Concluded from Page 157, P. M. Journal, for October.

deficiency from leakage. While too the air, in undergoing compression, was offering resistance to the power from the very commencement of the stroke, and that power was not producing any effect that could be considered useful, until when, towards the end of the stroke, the compression in the cylinder, exceeding that in the cooler, the air begins to be forced therein; it is to be remembered that owing to the imperfection of the best cylinders, valves, and such apparatus that can be made, only a small proportion of the expansive force of the air or steam can be employed, and the part so lost, increases with the compression adopted.

Again: from the excessively varying resistance of air when undergoing great compression, such violence is done to all parts of the pump, that it cannot long continue to work tight and true—and this was the principal reason of the abandonment of the Croydon atmospheric line; the air, in undergoing compression, came so suddenly to a maximum of resistance, as to resemble an explosion in its effects. The great inertia and small elasticity of water, render that fluid most appropriate for being raised by pumps acted on by natural powers; but the small inertia and great elasticity of air, render it almost impossible to be dealt with continuedly at high degrees of tension.

But the most importaut objection to the employment of a high degree of compression, which is necessary to the introduction of the expansive action of the air at all, exists in the difference between the amount of increase in temperature on a certain compression, and decrease of temperature on the same quantity of expansion in air; a difference not practically sensible in low compressions, but so very much so in higher ones, as to waste the mechanical power in producing heat, which can never be made up for by the small amount of subsequent cooling. In any particular compression, a certain per centage only of the acquired heat can be got rid of in the cooler; unless therefore the decrease of heat on expansion notably exceeds the per centage of heat of compression still remaining, no absolute cooling ou the initial state of the air will be effected. Thus, let the heat produced by a certain compression be 17°, and let 7 per cent. of that heat be got rid of iu the cooler, leaving therefore 5° still outstanding, the decrease of temperature consequent on the same expansion will be 16°, and the amount of cooling consequently 16 — 5, or 11°; and only 1°, or 17 — 16 of heat will have been produced.

But let such a compression be employed as shall produce an increase of heat of 1850°, 7 per cent. of this being cooled off, leave outstanding 555°; and the decrease of temperature consequent on the air expanding from that compression, being only 398°, leaves outstanding still, 157°; or the air sought to he cooled is, after all, heated to that great extent above what it was at first, and the enormous amount of 1452° of heat, or 1850 — 398, have been uselessly produced; and this, however perfect the method or complete the degree of cooling, and the carrying away of the heat of the compressed air in the cooler may have been.

The effect of this law of the different results of compression and expansion being thus important, it becomes necessary to ascertain its exact amount; and as this is hardly possihle to be done by experiment, unless very great expense be incurred, recourse must be had to theory; and this may be carried out with perfect safety, when one point in the scale has been so satisfactorily fixed by the Kinneil experiment. Both Carnot's and Rankine's theories are, however, rather difficult in their application, and depend on the specific heat of air, a quantity by no means well ascertained. A new theoretical view has however been just produced by my friend, Mr. W. Petrie, C. E., and has the advantage of being immediate in its result, and depending on no theory of heat, but merely the fact of heat being the cause of the apparently self-repulsive or expansive power of gases, and on the well-determined amount of this expansion of gas by heat, viz. $\frac{1}{480}$ for 1° Fahr.

On this well-grounded idea, he has computed a table, showing the decrease and increase of temperature on certain amounts of expansion and compression of air; aud the truth of the table, and the idea on which it is founded, are well borne out by the close agreement with the Kinneil experimental results already detailed. The table is as follows:—

Variation in the bulk of a portion of air.	Variation of temperature from 60° Fahr. produced thereby. Degrees.
Expanded to ∞	508·0
1000 volumes,	457·2
500	444·0
200	421·0
100	398·0
50	370·0
20	320·8
10	272·2
5	210·9
3	155·9
Expanded to 2·5	133·7
2	104·8
1·9	97·9
1·8	90·4
1·7	82·3
1·6	73·7
1·5	64·2
1·4	53·9
1·3	42·5
1·2	30·0
1·1	15·9
1·0	0·0
Compressed to 0·9 of the volume,	+ 17·1
0·8	+ 39·1
0·7	+ 64·2
0·6	+ 94·3
0·5	+ 132·0
0·4	+ 181·5
0·3	+ 251.0
0·2	+ 360·7
0·1	+ 586·4
0·05	+ 870·9
0·02	+ 1363·5
0·01	+ 1850·1
0·005	+ 2462·8
0·002	+ 3524·0
0·001	+ 4572·0
0·000	+ ∞

To adapt this table to any other initial temperature than 60° Fahr., add $\frac{1}{508}$ to the tahular quantity for every degree by which the initial temperature is higher, and subtract the same for every degree by which it is lower.

The merest glance at this table shows the advantage of using the lowest compression compatihle with the quantity of cooling required; and further, that this degree of compression will, in all ordiuary cases, be so very trifling, that the expansive force of the escaping air would not overcome the friction of the apparatus on which it would have to be employed, if utilised mechanically. The machine resolves itself, therefore, merely into a pump, as simple as could be desired in the colonies, where good mechanical workmen are generally scarce.

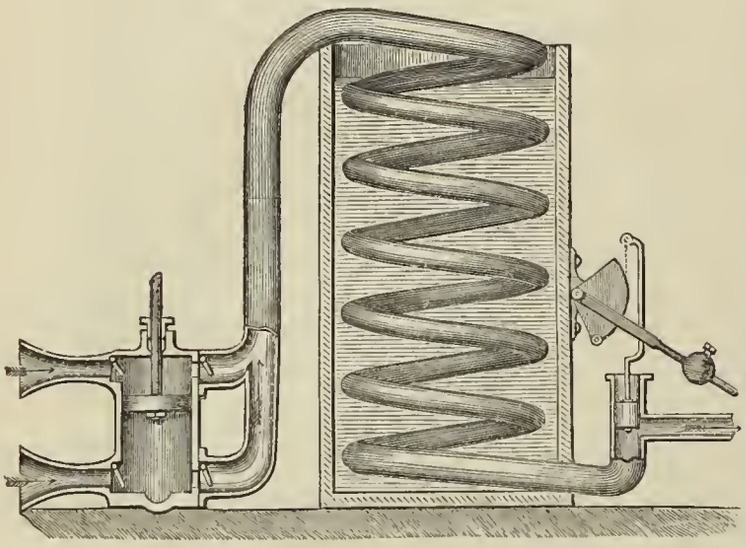
The size for a one-horse power engine, or its near equivalent, two bullocks, and working at ½ of an atmosphere pressure so as to give about 90 cubic foot of air per minute, and cooled at least 20°, making full allowance for losses from various sources, would be 1 foot in diameter, and 1·5 feet in length, or in the stroke of the piston, the number of strokes being about 30 or 35 *double* ones per minute. This gives a speed to the piston of certainly only 90 or 100 feet per minute; but it is much better to have a large pump moving slowly for this purpose, than a small one moving quickly, as in this case so much needless heat would be produced by the friction of the pistons. The slow motion of the bullocks can likewise, in the former case, be so much the more easily converted into the necessary speed for working the pumps, and would be done on the supposition of the diameter of the bullock path being 30 feet; and it should not be less, to allow the animals to have a fair and straight pull, and their rate of walking two miles an hour, by two sets of wheels and pinions, the first from the large cog wheel on the bullock shaft producing an increase of 5 or 6 times, and the second ahout 3. A good engineer should be employed for the pump, and metallic piston and valves be adopted; and the whole should be fitted into a frame in this country, with connecting rod and crank axle applied, so that it might be easily adapted to any existing mills in India; and that no injury should baply accrue to the piston or the interior of the barrel by clumsy workmen inserting too long or short a connecting rod.

The next part of the apparatus is the cooler, which may be made in various forms, as a copper pipe, one or two inches in diameter, very thin, in order to conduct heat more readily, and about 100 feet long, with a spring-valve at the end farthest from the pump, and capable of being loaded with any particular pressure per square inch which it may be desirable to work at. The pipe may be conveniently coiled up and placed in a barrel full of water, entering at the top, and leaving it at the bottom; so that the air, gradually cooled as it goes along the pipe, may meet the coldest water at the bottom of the worm, and thus be more completely refrigerated. A small supply of fresh cool water from the river or spring or tank, or wherever the supply is drawn from, must

be allowed to trickle into the tub, and be conducted by a pipe to the bottom, while an exit being made at the top, the water heated by the compression of the air will flow off in a continued stream. I have not yet made any experiments on the quantity of cooling surface of pipe required, but a few feet more or less will certainly accomplish it, and will not much increase the expense of the first apparatus which may be made.

The proposed form is shown in fig. 1, where, on the left-hand side, is shown the double-acting pump, which compresses the air into the pipe in the tub, where it accumulates until of sufficient elasticity to raise the loaded piston-valve on the right; a portion then escapes, until

Fig. 1.



5-16th inch = 1 foot.

the remaining air is less elastic than the pressure on the valve; and at every succeeding stroke of the pump, a quantity of air, equivalent to that forced in at one end of the pipe, will escape from the other end, after having parted with its heat of compression to the water, and expanding immediately, and cooling, will be available at once for the sanitary application to rooms.

The form of cooler mentioned above, is but one of many which may be variously applicable in different situations; sometimes a flat cooler may be preferable, and often it may be of advantage to pass the compressed air through another coil of pipe, over which water is allowed to drip, or which is covered with a damp cloth, so that the cold of evaporation may be superadded to any procurable from the temperature of the water.

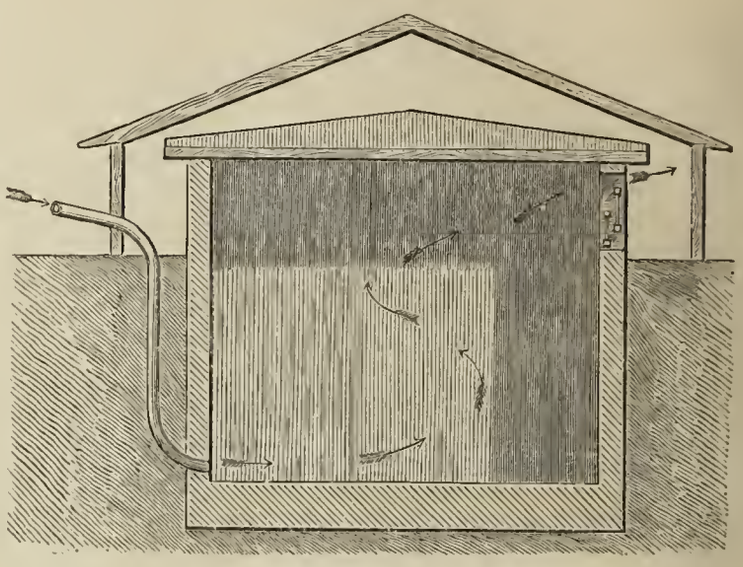
The next point is the application of the cooled air to a room, so as to keep it effectually cooled, and at the same time well ventilated; and this is, fortunately, very easy to be done, and in the most perfect manner.

The cold air being heavier than warm air, evidently cannot be applied to upper rooms, or even to lower rooms, with doors and windows reaching down to the ground; for it will escape there as water would, flowing away, and diffusing itself everywhere over the lowest places. But if a wall several feet high be built all round the room proposed to be cooled, or, still better, if it be sunk that depth in the ground, the cold air will be confined as if in a tank, and that which has last come from the pump will occupy the lowest place, while the former supplies, in proportion as they have been longer in the room, will be warmed up, and rise to the higher parts, where an exit may be conveniently afforded by the opening of an upper sash of a window. Then, as the air expired from the lungs of persons likewise rises in a room, from the high temperature more than balancing the greater specific gravity of the gas, this will be carried away also in the general upward stream; and thus a person placed in the room will never have to breathe the same air *twice* over—a long-sought desideratum in ventilation—and the room will be constantly filled, at least towards its lower parts, with the coldest and freshest air which the machine can supply.

Fig. 2 is a vertical section of a room so sunk in the ground, and supplied with cold air by a pipe coming from the cooler, the arrows showing the course of the air in passing through the room, and out at last through the window.

This is all that is required for the complete cooling and ventilation of the majority of places in India; but in some, as we hinted above, additional means are needed for the purpose of *drying* the cold air.

Fig. 2.

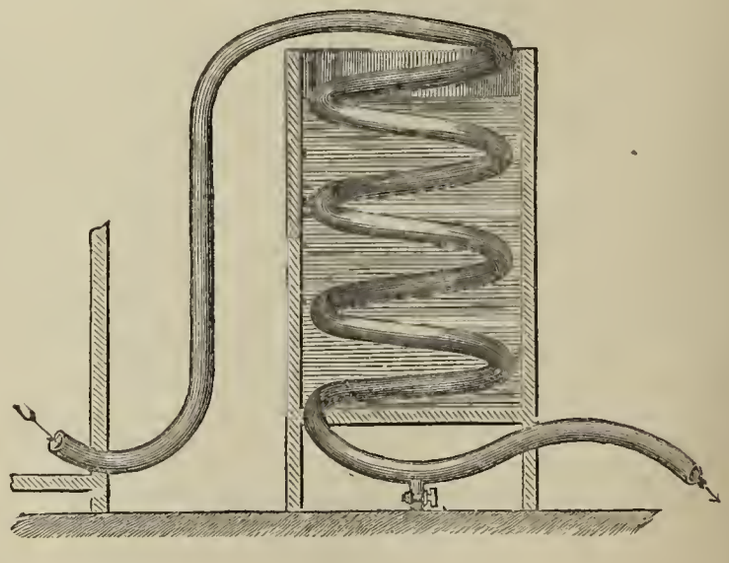


1-16th inch = 1 foot.

A method of effecting this without heating the air, is by exposing it to metallic surfaces at a lower temperature, when the moisture in the air will be condensed and deposited on the cold metal. This may be brought about by passing the air, after its escape from under the spring-valve of the cooler, through another worm of pipe in a tub where the water is kept always at a slightly lower temperature than the air, either by having a second pump compressing other air more than the first, and then allowing it to bubble through the water of the drying tub, or by dissolving in it continually large quantities of saltpetre and sal-ammoniac—one of the most useful of freezing mixtures—as the salts, on evaporation, recrystallize separately; and the same stock may therefore be used over and over again indefinitely; besides which, they are both found in great abundance in India. It is only necessary to have a person occasionally to throw the salts into the tub; and drawing off the saturated water, expose it to the evaporating influence of the sun and the wind, or, in default of those, to a fire.

In fig. 3, a representation of the dryer of the cooled and expanded air is given. It is merely a thin copper tube, open at both ends, and immersed as to its middle in a tub of water, to which the refrigeration is to

Fig. 3.



5-16th inch = 1 foot.

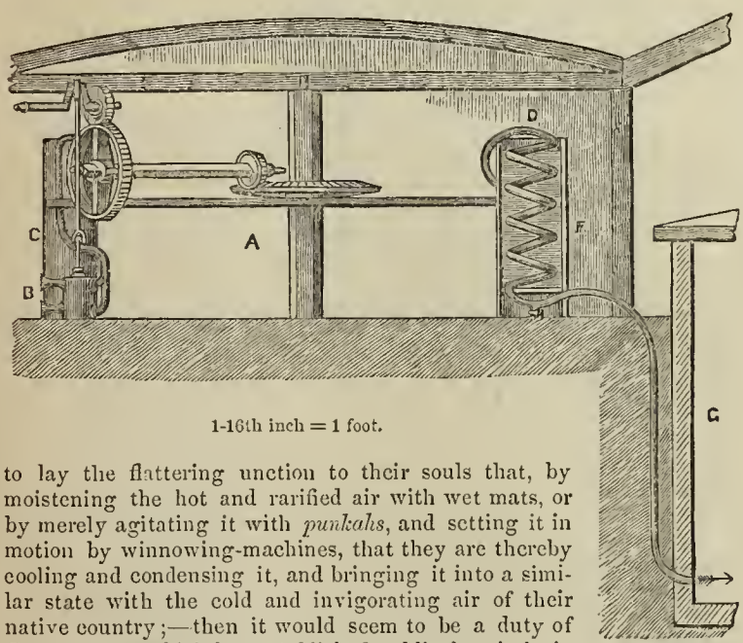
be applied. At the lowest bend of the pipe, after it has left the barrel, is a stop-cock, to draw off the water which may be condensed under the tube, and the air may then be allowed to enter the room, and be breathed by its inmates.

This completes the apparatus, and the whole is shown in plan and section, in figs. 4 and 5. A light roof is here thrown over the bullock-mill, pumps, and tubs, and is continued over the room to be cooled; as a second roof, with a space for the wind to blow through, is so excellent a defence against the heat of the sun. The mill is of the simplest form, and such as is now generally made in this country in iron, and of a portable form, under the name of a "horse-work," as used for thrashing-machines; the pump, pipes, and valves would of course also be made here, and would not be difficult of transport; while the water-tubs would be easily made on the spot by Indian carpenters, and in a form best fitted to the local peculiarities.

To make all this for the first time, and to add it to a house already built, may seem somewhat expensive; but looking at it in an *à priori* sort of view, there does not seem so much to be done as if, to a simple house where rooms should be garnished with nothing but doors and windows, it was proposed to add chimneys, fireplaces, grates, fenders, fire-irons, and chimney-pieces.

The complete proof, however, and that which is so much to be desired, is in the actual making and applying of such an apparatus; and if private persons be afraid of trying new experiments, and are content

Fig. 4.



1-16th inch = 1 foot.

to lay the flattering unction to their souls that, by moistening the hot and rarified air with wet mats, or by merely agitating it with *punkahs*, and setting it in motion by winnowing-machines, that they are thereby cooling and condensing it, and bringing it into a similar state with the cold and invigorating air of their native country;—then it would seem to be a duty of Government, which has established public hospitals in those climates for the cure of the sick, to adopt any method which, while it is neither expensive nor difficult, yet promises certainly to supply one of the desiderated means of cure, and to meet the very cause which has sent almost all the patients to the hospitals. At present, such patients must either die there in the hot atmosphere, or are sent home at great expense. What the numbers may be of these latter I know not, but conclude that they can only be reckoned by hundreds; while the cost of the passage home of three or four individuals only, would be abundantly sufficient for the making of the first experimental machine.

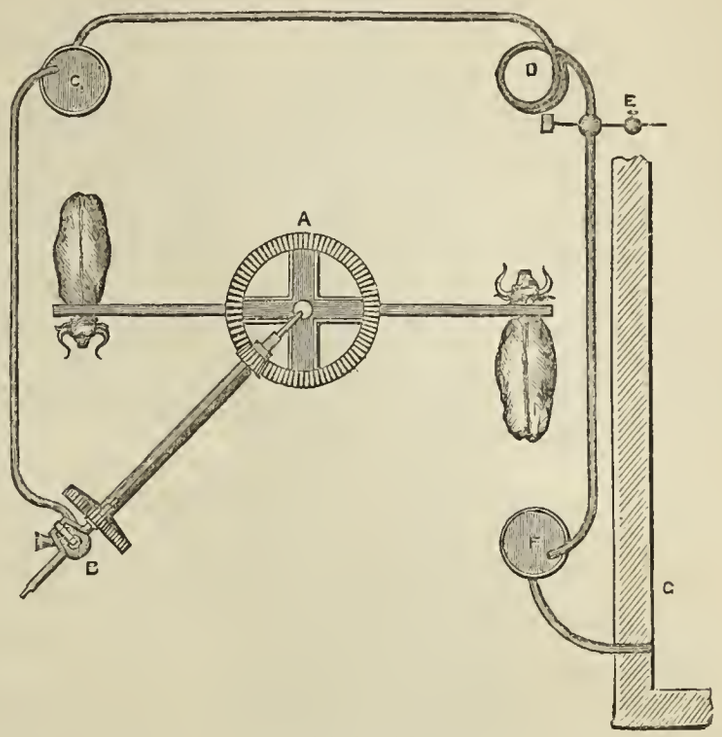
Here, however, I must leave the matter, having neither the time nor means to prosecute it further; and will merely conclude with the notice of a few suggestions which arise from the foregoing facts, and which may be enumerated as the following corollaries:—

Cor. 1. On a mode of producing heat by mechanical force, and which may possibly be useful in many cold countries where wind and water power are abundant. Frictional heat has been employed in some of the American mills, by making two plates of iron rub against each other under water; but this is by no means so profitable an application of power as by the compression of air, and by having a coil of copper tube in the room, and compressing the air only $\frac{1}{5}$th of its bulk, a heat of 360° Fahr. above the external temperature would be obtained.

This manner of producing heat was illustrated by Sir J. Herschel, in a note to his "Treatise on Natural Philosophy," rather, certainly, as a theoretic principle, than in a practical way; but as I was led by it to the method of cooling air, I am bound to acknowledge my obligations. The first person whom I am acquainted with, as having proposed the method for any industrial purpose, is the Rev. Dr. Adamson, the Principal of the South African College in Cape Town; but I am not aware of his having entered upon any inquiry into the thermotic effect of compression, and the consequent size of the windmill which he would have to employ to heat a house of certain size.

When however, the heat is wished to be applied at once to the air

Fig. 5.



1-16th inch = 1 foot.

which is breathed and fills the room, another plan may be profitably employed. Let there be a coil of pipe as before, in a vessel of water outside the house, and let the pump be used for the purpose of extracting the air out of this pipe, at the opposite end of which there is to be a very small hole, at which the air may enter, but not so quickly or in such quantity as it is extracted at the other. The consequence of this will evidently be a rarefaction or expansion of the air in the tube; and the result of that is a lowering of the temperature. But it will soon be warmed up again, by the conduction and radiation of the pipe, to the heat of the water, or to its original temperature; and then, on being extracted by the pump, and thrown out into the atmosphere, it will be compressed to its original density, and will then rise above the heat of the surrounding atmosphere, to a degree proportioned to the compression so occasioned. The warming is thus produced at once where it is wanted, and has not, as in the former case, to be communicated slowly by conduction and radiation through the copper, from air on one side to air on the other; a very slow plan, on account of the small conductive power of gases.

Cor. 2. In preparing and fitting the tropical air for the purposes of human life, we have hitherto considered only its affections as to heat and moisture; but there may, doubtless, be many gases and finely divided substances diffused through it, giving it many of its unhealthy qualities. Chemical analysis has not yet been able to detail them, but that is rather from the comparative rudeness of the methods, than from the non-existence of the extraneous matter; for the sense of smell may often be powerfully affected, as with the scent of plants, and yet a chemist is unable to discover anything different in the air immediately round a plant, and at a little distance from it. One reason of the non-success which has attended analyses of air, would seem to be the small quantities of air usually operated upon; so small, indeed, that it is not to be expected that the foreign substances should make themselves appreciable in the nicest balance.

Our cooling machine, however, forms at once an apparatus in which air may be analysed on as large a scale as may be desired; for it is only necessary to half fill the worm-pipe in the cooling tub with such chemical fluids as the aerial impurities may be expected to combine with; and the machine being put to work in the usual way, will pump all the air through the fluid, and to an extent of several tons weight of air in the course of the day; so that then the smallest admixture of any foreign substance would have so accumulated its effect on the fluid, as to be most probably sensible to ordinary chemical examination.

Cor. 3. If what has been said in the early part of the paper of the difference between air, cool merely to the feelings, and that which is

cold to the thermometer, be true, *i. e.* that the former being really high in temperature, and merely feeling cool to the skin by being agitated by a fan, or mixed with watery vapour, is rarified to the full amount of its real temperature, and so forms a weak and diluted sustenance for the lungs; while the latter, being really low in temperature, is dense, and gives, proportionately, concentrated food to the breathing organs; if this be true, which it cannot but be, then it follows, that air mechanically compressed, and breathed in that state, may be very beneficial in many cases of disease, when the lungs may be very small, or may in part be destroyed by consumption or other malady; for by continued compression, as much oxygen may be contained in a cubic inch of the compressed air, as in a hundred of the ordinary pressure and temperature of the atmosphere. To carry out the principle in such a manner as to be adaptable to all cases of temperature and pressure, it would be necessary to have a small air-tight room, made probably of iron, connected at one end with the pipe coming from the escape-valve of the cooling worm, and having a similar valve at the other end. The reason of not making the pump force the air at once into the room, is, that the temperature would thereby be too much raised; but by having a greater compression in the worm-cooler than in the room, the latter may be supplied with air of any desired temperature and pressure; and Mr. Petrie's table, given above, will show exactly the pressures to which the two escape-valves should be set, for any particular case.

RELATION OF THE DENSITY AND ELASTICITY OF STEAM.

The following table, although of no great practical importance in itself, possesses some degree of interest as a systematic expression of the relative variation of the density and elasticity of steam at saturation, for a given variation of the temperature. It is from the arithmetical terms of this relation, that the common opinion of the greater economy of high-pressure steam is derived.

The column containing the numerical values of the elasticity corresponding to the given points of temperature, is derived directly from M. Regnault's table of experimental pressures for the mercurial thermometer. The numbers represent the actual elasticities, measured in terms of the pressure which the steam is found capable of sustaining at 32° Fahr., taken = 1. This unit, it may be stated, is given by M. Regnault at 4·6 millimètres of mercury, = 0·181102 English inches, = 0·00605 of an *atmosphere* of 14·687 lbs. on the square inch of surface. Expressed in weight, it is therefore eqivalent to 0·088897 lb. on the unit of area, and the logarithm is 8·9488858.

The corresponding numerical values of the density in the succeeding column, are those obtained when the density of the steam at 32° Fahr., under the above-named pressure, is taken as unity. If the density be measured by the weight of steam in a cubic foot, the density, at this assumed limit of the temperature, is = 0·0003040941b., of which the logarithm is 6·4830077.

The last column of the table shows what the density would become were it to increase at the same rate as the elasticity, on the assumption that the coefficient of expansion is = $\frac{1}{491}$, as found by M. Regnault. The numbers accordingly form an increasing arithmetical series, with a common difference of ·03665 for 18 degrees of temperature.

Temperature.	Elasticity, in terms of the elasticity at 32°, taken = 1.	Density, in terms of the density at 32°, taken = 1.	The actual density being = 1, that corresponding to the elasticity is—
32°	1.	1.	1.
50	1.991	1.921	1.03665
68	3.780	3.522	1.07330
86	6.859	6.194	1.10995
104	11.937	10.411	1.14660
122	19.996	16.898	1.18325
140	32.345	26.515	1.21990
158	50.672	40 326	1.25655
176	77.095	59.616	1.29320
194	114.228	85.896	1.32985
212	165.214	120,905	1.36650
230	233.261	166.241	1.40315
248	322.391	223.914	1.43980
266	438.113	296.734	1.47645
284	583.044	385.331	1.51310
302	767.826	495.452	1.54975
320	995.651	627.618	1.58640
338	1270.000	782.478	1.62305
356	1601.305	964.816	1.65970
374	2000.87	1179.51	1.69635
392	2469.57	1425.06	1.73300
410	3020.65	1706.92	1.76965
428	3657.18	2024.68	1.80630
446	4382.61	2378.04	1.84295

If the units of elasticity and density be taken at the temperature of 212°, which in some respects is more convenient, this table, calculated from that point, assumes the following form:—

Temperature.	Elasticity, in terms of that at 212°, taken = 1.	Density, in terms of the density at 212°, taken = 1.	The actual density being = 1, that corresponding to the elasticity is—
212°	1·	1·	1·
230	1·412	1·375	1·02682
248	1·951	1·852	1·05364
266	2·652	2·451	1·08046
284	3·529	3·187	1·10728
302	4·647	4·098	1·13410
320	6·026	5·191	1·16092
338	7·687	6·472	1·18774
356	9·692	7·980	1·21456
374	12·111	9·756	1·24138
392	14·947	11·786	1·26820
410	18·283	14·118	1·29502
428	22·136	16·746	1·32184
446	26·526	19·669	1·34866

It is scarcely necessary to state, that the column of elasticity in this table represents simply the total pressure of the steam in atmospheres, at the corresponding temperatures in the preceding column.

W. M. Buchanan.

IMPROVEMENTS IN CALICO-PRINTING MACHINERY. WRIGHT'S MOULD-MAKING MACHINE FOR PRODUCING PRINTING SURFACES.

In 1843, a most ingenious plan was invented and patented by Mr. Joseph Burch of Macclesfield, for producing surfaces for printing calicoes, whereby "surface printing" was rendered capable of accomplishing the most minute work, with a degree of accuracy until then unknown in blockwork. The system pursued was the formation of intaglio matrices of the designs in wood, from which relief-impression plates were cast in metal. The peculiarity of this process consists chiefly in the mode adopted for producing the matrix, which is by heated steel punches, made to indent the wood, by the joint action of heat and pressure. A row of small punches are set vertically in the lower ends of a set of sliding heaters, which pass through a gas-heating box, the heat thus given by the gas flame being communicated to the punches by metallic contact.

The wood block to be prepared as the matrix or mould, is placed, with its design drawn upon its surface, on a table beneath the lower ends of the heated punches, which are brought to bear, individually, upon the lines of the pattern—so as to press and burn out the device—by means of a treadle worked by the foot of the attendant.

In this arrangement—which, however, has been tolerably successful—there are several disadvantages, which Mr. Wright has obviated in his ingenious improvement upon Mr. Burch's original plan.

These are:—

1. In the act of punching, the heater carrying the punch, is removed from direct exposure to the heat of the gas flame; thus the heat of the punch constantly diminishes whilst in use; and, to enable the operator to go steadily on with his work, he must have a series of punches and heaters in one machine, so that the cooled punches may be again heated after use, whilst a freshly-heated one is in action. Thus, although only one punch is required at once, the construction of the machine involves the expense of several, and each time that a change is made, an inconvenience arises from the change of position of the punch in reference to the design.

2. The alternate heating and cooling of the apparatus produces the disadvantageous effects of alternate expansion and contraction of the parts.

3. The ordinary Argand gas-burner being used, a great loss of heat is sustained by the indirect application of the flame to the punch-holder or heater.

4. The heaters themselves being made to slide in mere holes formed in a guide bracket, great inaccuracy results.

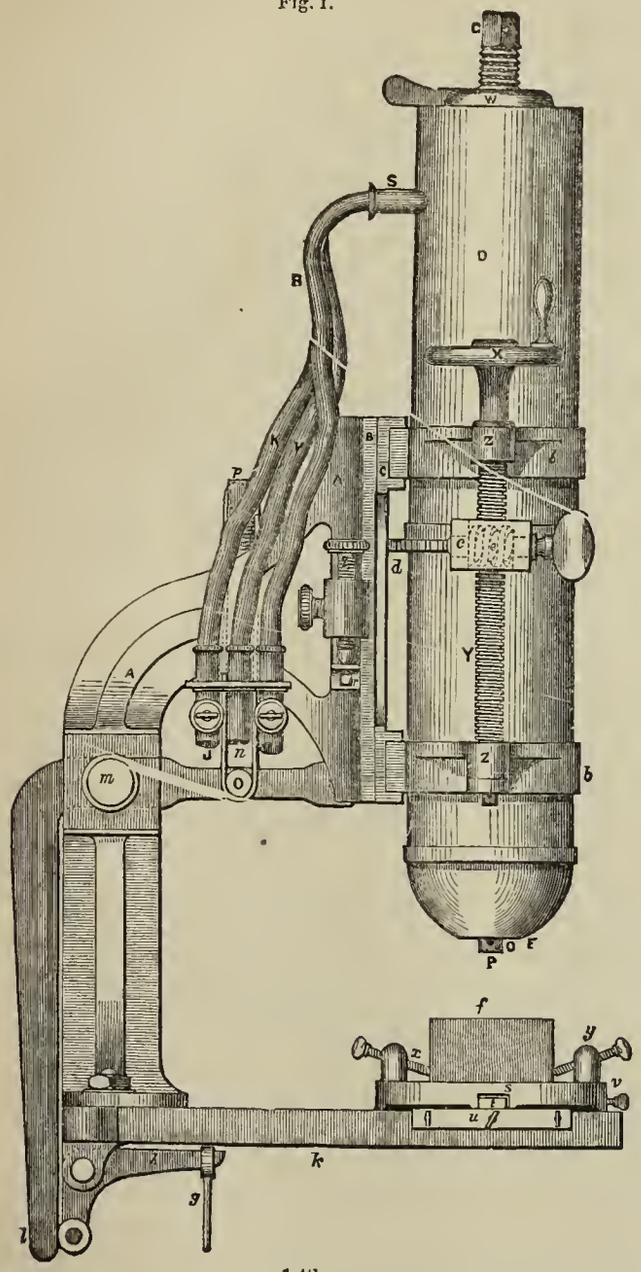
Mr. John Wright of Glasgow, who, as a practical engraver to calico-printers, has been powerfully impressed with the defects which we have mentioned, has modified the machine to the form represented in our three engravings.

Fig. 1 is a complete side elevation of the apparatus; fig. 2 is a corresponding front sectional elevation; and fig. 3 is a plan.

A, Is the fixed frame of the machine, the upper projecting portion of which, at B, is faced and formed with side grooved pieces, to receive the slide, C, of the barrel, D, carrying the heated punch, one only of which is used in each of the machines. The barrel is a triple one—that is to say, it is formed of three concentric tubes or cylinders, secured together

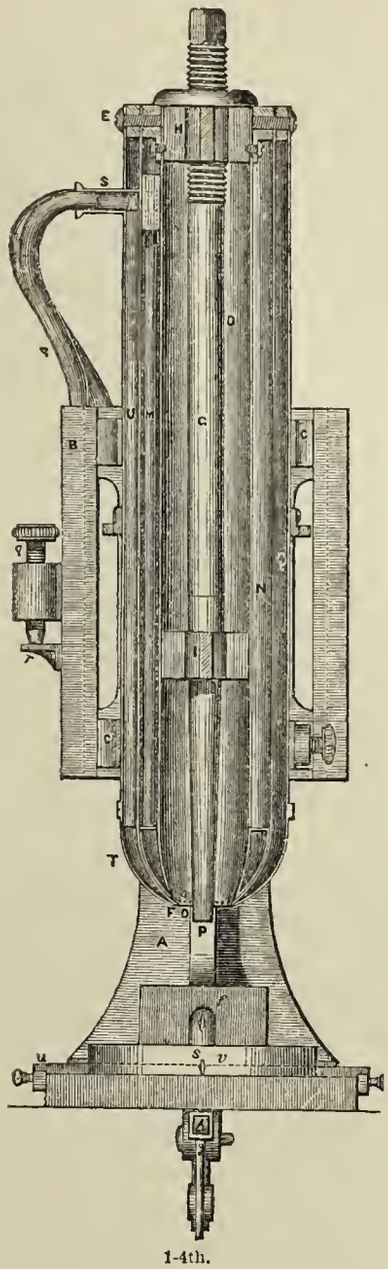
at the top by screws, as at E, whilst at the bottom they are all rounded inwards, and their extreme edges are brought together, as at F, where the heat of the gas-flame is applied to the punch. The punch-holder, through which also the heat from the gas-flame is communicated to the punch, is at G, in the centre of the barrel. It passes through a fixed nut, H, at the top of the barrel, in which its height is adjustable by a key acting

Fig. 1.



1-4th.

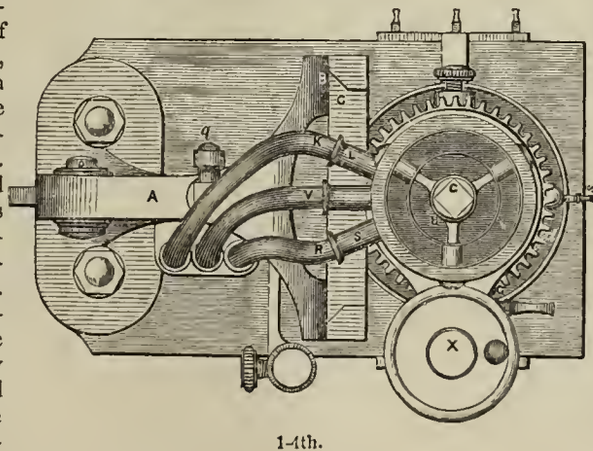
Fig. 2.



1-4th.

on the square at the top. Its lower portion is also guided by a fixed piece at I, in the interior of the barrel. The gas supplying the heating burner is brought by the pipe, shown broken at J, where there is a stopcock regulating the flow through the flexible tube, K, of gutta-percha or India-rubber. The other end of this tube is attached to a short branch at L, on the outer cylinder of the barrel, D, and from this branch a tube, M, descends through one side of the air-space, N, to the annular gas-burner, O, in the rounded end of the barrel. A series of minute apertures, *a*, are formed round the inner edge of this burner to act as gas-jets, the flame from which, thus completely encircles the end, P, of the punch-holder, where the punch enters it as a socket. The outer division, Q, of the barrel is a water-space, to keep the barrel cool. A flexible tube, R, similar to that employed to convey the gas, keeps up a constant supply of cold water, which passes into the barrel by the branch, S, and is conducted down to the bottom of the division at T, by the tube, U, so that the water, in its coolest state, is taken direct to the hottest portion of the barrel, the heated water and vapour being carried off from the water-space by the third flexible tube, V, a constant circulation being thus kept up as the cool water abstracts the superfluous heat given off by the gas-flame.

Fig. 3.



1-4th.

As before explained, in reference to the heating punch-holder, the punch may be elevated or depressed in the barrel, by the screwed portion at the top; and when adjusted, the holder is fixed in its position by the friction-plate, W, adjustable by a lever handle to screw down upon the top of the barrel. The barrel again may be set higher or lower, in reference to the slide of the framing by the hand-wheel, X, on the vertical screwed spindle, Y. This spindle passes through two plain guides, Z, on the holding rings, *b*, carried by the slide, C, and acting as supports for the barrel; and its screwed portion passes through a nut formed by the projection, C, fast on the barrel. Thus, as the shoulders on the spindle prevent it from moving longitudinally, when turned in either direction, the action of the screw upon the barrel-nut elevates or depresses the barrel in its two rings, *b*. An ad-

justing action is also provided for giving the barrel a movement on its axis, to set the punch to any required angle with the work This is effected by the worm-wheel, *d*, on the barrel, which is actuated by the worm or endless screw, *e*, carried in bearings in the forked end of the bracket or projection, *e*.

In puncbing or impressing a device upon the wood block, *f*, the punching movement is given to the barrel by a treadle in connection with the link, *g*, on the bell-crank, *h*, carried on a stud beneath the table, *k*, carrying the work. The shorter arm of this crank acts against the end, *l*, of the long bent lever oscillating upon a centre at *m;* whilst the opposite lever arm gears by means of its forked end, with a stud carried on the slide, *c*, of the barrel. In this way the foot on the treadle gives the downward movement to the barrel, whilst it is elevated for the succeeding stroke by an elastic band spring, *n*, passed round a stud, *o*, on the lever arm, and held by an adjustable screw stud, *p*, above. To regulate the amount of descent of the barrel, and consequently the extent of the penetration of the punch into the block, the screw, *q*, is used, being arranged to bear earlier or later, as may be required, upon a fixed projection at *r*.

The block, *f*, on which the device is to be moulded or impressed, is placed upon the circular plate, *s*, grooved on its lower surface, to slide upon the bar, *t*, held by end-pieces, *u*, adjustable by set-screws to the edges of the table, *k*. A set-screw, *v*, passes through the plate, *s*, and bears upon the edge of the bar, *t*, against which also the ends of a curved spring bear, the set-screw being passed through the centre of the spring to adjust its holding pressure upon the bar. The block is held upon the traversing plate, *s*, by the two set-screws, *x*, passing through short pillars, *y*, near its periphery.

Considerable ingenuity is here shown in the arrangements for keeping the heat constantly upon the punches, which modification alone entitles it to precedence of the original machine. We have seen it executing the most intricate designs, on a scale quite unapproachable by any other similar contrivance, with an amount of accuracy which leaves nothing to be desired.

PHYSICAL GEOGRAPHY.*

No. III.

River Deltas.—All streams whatsoever, carry, suspended in their waters, a quantity of earthy matter, which is again deposited when their motion is stopped or greatly retarded. The quantity of suspended matter principally depends upon the volume of water, the force of the current, and the mineralogical nature of the bed. The deposits are usually made at the mouth of the stream, that is, at the point where they enter a lake or the sea; and as they have a tendency, from mechanical causes, to take the form of a triangle, they have obtained the name of Delta, a Greek letter possessing that shape. The action of a running stream is first to erode, then to transport, and lastly, to deposit. Its erosive effect has naturally reference to the softness or hardness of the materials with which it comes into contact; its transporting power will depend upon the quantity of water, and the strength with which it rolls onward; but when it reaches the point where its force is checked, it will immediately begin to throw down the matters which load its waters. The detritus thus carried off from many points, to be laid down at a single and a separate one, though of enormous amount in the case of many large rivers, is really imperceptible to persons who do not closely examine into the matter. The river urges endlessly forward its discoloured waters before their eyes, but they never think of pausing to inquire what is the amount of solid material which is thus shifting its place, and slowly effecting great changes on the earth's surface; and when the delta at the river's mouth is pointed out to them, they hear, with an incredulous smile, that the solid expanse of ground spreading far out of sight, covered with a carpet of grass, and bearing tall trees, was brought down, particle by particle, in drops of water, from far distant mountains and valleys.

The process of forming a delta seems to be this; at the point where the detritus begins to be dropped, a bank is created, which rises until it reaches the surface of the water, and becomes an island. The river is thus divided into two arms, each of which may again be divided by a repetition of the process. An alluvial tract is thus gradually formed. The soft mud slowly acquires consistence, seeds are thrown upon it by the winds or by the water, and vegetation in time clothes the whole. All this is a work of time, greater or less, according to a variety of circumstances which will readily occur to the mind. Other particulars regarding the formation of deltas will be best gathered from a description of some of those which are best known. Deltas are divided by Lyell into those formed in lakes, in inland seas, and on the borders of the ocean. The nature of the organic remains is the most characteristic distinction between lacustrine and marine deltas. The circumstances under which the inorganic matter is laid down in lakes and inland seas, are pretty much the same, but differ from those which attend the deposits on the shores of oceans, where tides and currents occasion the appearance of another set of phenomena.

The quantity of matter poured into the Adriatic by the Po and the Adige, assisted by numerous minor streams, draining two lofty chains of mountains, the Alps and the Apennines, has been so great, that during the last 2,000 years there has been an accession of land for the length of 100 miles, of from two to twenty miles in breadth. The lagunes which line that coast are being gradually filled up and converted into meadows. The true delta of the Po has been advancing into the sea at the mean annual rate of 70 yards for the last 250 years. In the time of Augustus, Adria was a seaport, but it is now 20 Italian miles inland. Ravenna was another seaport, and it is now 4 miles distant from the sea. Deposits of sand and mud extend under water half-way across the gulf, which is only a shallow body of water.

The lake of Geneva affords a good example of a lacustrine delta. The Rhone enters the lake as a turbid and discoloured stream, and leaves it perfectly transparent. Port-Vallais, a town situate, eight hundred years ago, on the water's edge, at the upper end, is now 1½ mile inland. The rest of the delta is a marsh, 5 or 6 miles long, raised very little above the water. On sounding the lake, it was discovered that the deposits extend under water, over a slightly sloping bed, for nearly two miles from the mouth of the Rhone, and are probably from 600 to 900 feet thick at the head of the lake.

The Mediterranean delta of the Rhone is an example of the third kind of delta. After issuing from the Lake of Geneva, the Rhone is swollen by rivers bringing large quantities of detritus along with them, so that when it reaches the Mediterranean, it is so turbid, that the waters of the sea are discoloured for six or seven miles. The advance of the delta is proved by the distance to which many buildings that once were upon the shore, have been removed in; and a tower erected by the shore, so lately as 1737, is now a mile from it. The joint action of the Rhone and the currents of the sea has thrown up considerable sandbanks, enclosing lagoons which are filled alternately with salt and fresh water.

The country forming the delta of the Nile is usually computed to be 100 miles long, that is, from the apex of the triangle to the centre of the base on the coast, which is itself 200 miles in length, reckoning from the extreme ancient arm of the Nile on the east to that in the west. These, however, have been long blocked up, and the coast line of what is usually termed the delta is about 90 miles long. As the river has not a very rapid course, (about three miles an hour during floods,) it deposits mud for hundreds of miles before it reaches the delta, and the quantity laid down diminishes as the river approaches the sea. At Elephantine the land has been raised about 9 feet in 1,700 years, at Thebes about 7 feet, and at Cairo about 5 feet 10 inches. At this place the thickness of a year's deposit is about that of a thin sheet of pasteboard. Modern geologists seem to be of opinion, with Herodotus, that the delta was once a long narrow bay, penetrating, like the Red Sea, far inland. They believe that the waters of the sea once washed the rocks on which the pyramids of Memphis stand, and that the bay has been gradually filled up by the Nile. When we attempt to carry back our ideas to the remote period when the foundation of the delta was first laid, we are lost in the contemplation of so vast an interval of time.

The delta of the Ganges is on a still more enormous scale. Its apex is 220 miles from the sea, and its base is 200 miles in length. In the neighbourhood of the sea it is intersected by a labyrinth of creeks and streams. The sea is discoloured for a distance of 60 miles from the river's mouth with the matter brought down. The river is continually forming islands in its bed and then sweeping them away, and it is said that some of the present islands are as large as the Isle of Wight. The annual discharge of sediment is computed at upwards of 6,000 millions of cubic feet, (weighing more than 355 millions of tons): a quantity of matter nearly equal in weight and bulk to 60 pyramids composed of solid granite, of the same dimensions as those of the great pyramid of Egypt. One of such pyramids would weigh 6 millions of tons. If a fleet of 80 Indiamen, says Lyell, each freighted with 1,400 tons weight of mud, were to sail down the river, every hour of every day and night for four months continuously, they would only transport from the higher country to the sea, a mass of solid matter equal to that borne down by the Ganges in the four months of the flood season.

"The hydrographical basin of the Mississippi," says Sir Charles Lyell, "displays, on the grandest scale, the action of running water on the surface of a vast continent." The delta it has formed only represents a part of the solid matter brought down by the river, for much of

* For Nos. I. and II., see *Practical Mechanic's Journal*, Vol. II., pp. 149 and 202.

the impalpable mud is carried by tides and currents far into the sea. Yet the delta contains 13,600 square miles, and has an average thickness of probably 528 feet. It has been calculated from numerous experiments, that the average proportion of sediment is $\frac{1}{3000}$ of the volume of the water, and that the quantity of solid matter annually brought down is 3,702 millions of cubic feet. Consequently, it would take 67,000 years to deposit the matter forming the delta, but additional time (perhaps 33,000 years more) must he allowed for the formation of the alluvial plain, which is larger than the delta in area, and of similar structure, but probably of less depth. The experiments of Dr. Riddell upon which these calculations are founded, were not conducted during the season of the clearest water; and it is supposed that the average annual quantity of solid matter is probably not more than $\frac{1}{1700}$, in which case a much longer time must he allowed for the formation of the delta. The slow accumulation of matter in this great plain is proved by the numerous creet stumps with the roots attached, of the deciduous cypress, Taxodium distichum, (a tree that grew in swamps), some of which exhibit 2,000 rings of annual growth. The plain and delta have been computed to contain 31,200 square miles, an area larger than that of Ireland. A prodigious quantity of wood is annually floated down by the river and its tributaries. Masses of floating trees, arrested in their passage by an island or some other obstruction, accumulate to such an extent, that a bridge is formed from bank to hank. A raft 10 miles long, 220 yards wide, and 8 feet deep, was once formed in the Atchafalaya, an arm of the Mississippi, which, though rising and falling with the fluctuations of the tide, supported a luxuriant vegetation, some of the trees reaching the height of 60 feet—it took four years' continuous labour to clear it away.

Coal Fields.—Coal, the possession of which in large quantities has been a most important source of the prosperity of Great Britain, consists of mineralised vegetable matter, which has collected in hollows of that particular series of sedimentary deposits termed the carboniferous. Geologists are not agreed as to the mode in which the contents of a coal basin were brought together, and converted into the state in which we now find them. Some are of opinion that the vegetable matter was carried down hy rivers and deposited at their mouths. Others believe that the plants grew on the very spot where their remains are now found. Probably, coal fields have been formed in each of these ways. There are some coal deposits, however, which exhibit phenomena explainable hy neither hypothesis, and it must he owned that the question is beset with difficulties which have not yet been solved. However that may he, it seems clear, from an examination of the fossil remains, that the climate in which the plants flourished was remarkable for warmth, moisture, and equability, and therefore very different from the climate of the places where coal is principally accumulated. Ferns of many species, Calamites, Lepidodendra, Sigillariæ, and Stigmariæ, are the plants which chiefly constituted the flora of the carboniferous era. Palms, plants allied to the Banana tribe, and coniferous trees, also occurred. The Cryptogamic plants were of the most perfectly organized kinds; fungi, lichens, and the simple forms, never being met with. Speaking of the forest lands of the temperate zone, Humboldt states that the carbon contained in the trees on a given surface would not form a layer of seven lines in depth upon that surface in the course of one hundred years. What a prodigious length of time must it have occupied to form an accumulation of vegetable carbon such as we see in a coal-mine!

The hollows in which coal lies are usually shaped like a basin. These basins sometimes dip to a great depth. The bottom of the Liege coal bed is calculated to be 21,538 feet deep. The coal is arranged in strata of various thicknesses, alternating with incombustible beds, chiefly clay, slate and sandstone. Sometimes the layers of coal are less than an inch thick; at others, they are thirty feet thick. One of the coal fields in South Wales contains 84 seams of coal, alternating with 340 beds of sandstone, slate, and clay.

A coal field is always full of dislocations, called faults or dykes. At these places the strata have been split through vertically, and one side raised above the other, so that the seams are not continued in direct lines. The fissures thus made often extend for a distance of many miles, and are usually filled with clay.

The coal of England lies in four principal fields: 1. The Northumberland and Durham field, occupying an area of 924 square miles; 2. the Workington and Whitehaven field; 3. the Midland Counties field, extending for 1495 square miles, beneath the counties of Leicester, Worcester, Stafford, and Salop; 4. the Western Coal field, in South Wales, Gloucestershire, and Somersetshire.

The Northumbrian and Durham coal field is 924 square miles in extent, with a depth of good coal of 24 feet. There are about 80 layers of coal, varying from 6½ feet to a few inches in thickness, and separated by heds of clay and sandstone. The sea-shore passes over the middle of the field, so that a coal area of equal extent is supposed to be beneath the ocean. It is calculated that there is a supply of coal in this field to last from 1400 to 1700 years at the present rate of consumption. The coal field of South Wales, estimated at 1055 square miles, is 190 feet thick, and contains all qualities, from extremely bituminous coal to pure anthracite. The present annual consumption from this field amounts to 4½ millions of tons. It has been found by experiment, that—

1 lb. of Welsh coal will vaporize	9	lbs. of water.
1 lb. of Newcastle and Yorkshire coal,	7½	.....
1 lb. of Lancashire coal,	7	.....
1 lb. of Scotch coal,	6	.....

The Welsh coal excels all other British coals for the generation of steam and for general purposes.

Beneath the surface of the lowlands of Scotland is another immense coal field. This mineral has also been found in seventeen of the counties of Ireland. One twentieth of the area of Britain has coal beneath it; and the quantity raised annually is from 32 to 36 millions of tons, of which 2 millions are exported, 8 millions consumed by the iron-foundries, and 600,000 tons in making gas. In Belgium, $\frac{1}{22}$ of the area of the country is occupied by coal fields; and in France, $\frac{1}{210}$ part of the country.

The coal regions of North America may be divided into three principal tracts. 1. A central tract, extending from Tuscalosa, Alahama, to the west of Pennsylvania, and seeming to appear again in New Brunswick and Nova Scotia. 2. A tract which extends north-westward from Kentucky, crosses the Ohio, and passes through Illinois to the Mississippi. 3. A tract lying between lakes Erie, Huron, and Michigan. These deposits all rest conformably on the same rocks; and it is conjectured that they are all detached parts of a once continuous deposit, which had a length, from north-east to south-west, of about 720 miles, and a maximum breadth of about 180 miles. There are other small coal fields, with a total area of about 200 square miles.

Coal has been found in New South Wales, near Newcastle, Port Hunter, Van Dieman's Land (three deposits), South Esk, Hohart Town, and at Schouten Island, East coast, Tahiti, the Sandwich Islands, Vancouver's Island, Kerguelen's Land, at Labuan in Borneo, in Talcahuano Bay and Coleurra Bay, near Conception in Chili, and on Chatham Island, one of the Galipagos. Also at many places on all the three islands of New Zealand; and a stratum of coal has been recently found near Assouan on the Nile, in Upper Egypt. The coal discovered in Sandy Bay, Port Famine, straits of Magellan, is of the species termed brown coal, or lignite.

The following table explains itself:—

Countries.	Surface area of coal fields in square miles.	Tons dug in 1845.	Number of persons employed in coal mines, 1844.
United States of America.			
Bituminous,	133,132	1,750,000	
Anthracite (Penns.)	437	2,650,000	
British America.			
Bituminous,	18,000		
Great Britain.			
Bituminous,	8,139	31,500,000	110,233
Anthracite and Culm,	3,720		
Spain,	3,408		
France (62 mines),	1,719	4,141,600	29,320
Belgium,	518	4,960,000	38,400
Prussia,		3,500,000	
Austria,		700,000	

Erratic Blocks—are those large fragments of rock, usually rounded, but often angular and unworn, which are found, transported by some unknown power, at distances more or less great from the parent bed. There is a belt of such blocks, composed of granite, distributed along the flanks of the Jura mountains, 800 feet above the lake of Neufchatel. The same kind of granite does not occur, *in situ*, within a distance of 60 or 70 miles. One of these blocks, the Pierre-à-bot (Toadstone), is 64 feet long, 32 feet high, and 16 feet wide. Erratic blocks are found strewn over the plains of Germany, Russia, the Low Countries, and the coasts of Great Britain, the original rocks of which are situated, it is said, in the Scandinavian Alps. Blocks of granite can be traced from Viborg in Finland, to the neighbourhood of St. Petersburg and Moscow, a distance of from 140 to 150 leagues; and masses of sandstone have been transported from Lake Onega to Memel, no less than 245 leagues. In Canada, and in the northern part of the United States, as far as 36° 30′ N. lat., innumerable fragments of rock are scattered over the country, chiefly of sandstone and granite. An enormous area in Northern Europe, from Hamburg to the White Sea, 2000 miles long, by 400 or 500 miles broad, is covered with blocks, appearing to be identical in character with the rock formations of the Scandinavian mountains in the north-west.

This has been named the Great Northern Drift. The blocks are of granite, quartz rock, and greenstone, varying in size from 3 to 10 feet in diameter, and some contain as much as 40,000 cubic feet. They seem to be distributed in belts, with spaces between, the blocks diminishing in size as we advance southwards.

The cause of this remarkable and wide-spread phenomenon has been much canvassed. By some it is attributed to glaciers, which, at some former era, filled existing valleys, and extended into the plains. Others conceive that icebergs acted as floats for masses of rock. Others, again, are of opinion, that a violent rush of water, let loose from reservoirs in which it had been confined by the elevation of mountain chains, was the cause of dissemination.

Artesian Wells (so termed from their having originated in Artois) are perpendicular shafts, three or four inches in diameter, bored by means of an auger through the crust of the earth, until a sheet of water, resting upon an impermeable stratum, is reached. As the boring proceeds, a pipe is introduced to prevent the sides falling in. In passing downwards, it frequently happens that several subterranean pools and currents are crossed. When a reservoir subject to hydrostatic pressure is reached, the water rushes violently up the tube, and plays for some time out of its mouth like a fountain. It is necessary, in many instances, to carry the borings to the depth of several hundred feet. A well at Paris is 1800 feet deep. A well at Kissingen, in Bavaria, commenced several years ago, but only recently completed, has a depth of 1878½ feet. The water, on being reached, sprang to the height of 58 feet above the ground. It continued to run at the rate of 100 cubic feet per minute, the propelling power being a subterranean atmosphere of carbonic acid gas. The water is charged with 3¼ per cent. of common salt, which is taken from it by evaporation to the extent of 2700 tons annually. An Artesian boring at New Salzwerk, near Minden, reaches the depth of 2232 feet, the greatest known depth below the level of the sea; the temperature of the water is 91°, whilst the mean annual temperature of the air is 49°.

London (says the *Edinburgh Review*) is situated upon the lower tertiary or eocene formation; the upper stratum is a tenacious clay, the next is designated plastic clay, and is composed of argillaceous deposit and beds of sand; these rest upon the chalk formation, from 300 to 500 feet in thickness, not lying horizontally, but rising up all round like the sides of a basin, and coming to the surface at the Surrey and Chiltern hills. The water which falls upon and percolates through the edges of the porous chalk, is arrested at the bottom of the basin by a layer of gault or impermeable clay, and accumulates there until the whole stratum becomes charged with water; and the rim of the chalk basin being higher than the strata which it contains, the water, whenever the opportunity is given by a sufficiently deep well or hole, has a tendency, from the hydrostatic pressure, to rise through the superincumbent beds to its natural level above the surface of the ground.

The Geysers—are situated in the neighbourhood of Heela, about two and a half days' journey from Reikiavik, the capital, upon a piece of level ground, about twelve acres in extent, which is always enveloped in smoke and steam, arising from the numerous boiling springs and bogs of heated mud. In some places are isolated fountains, throwing up jets of steam mixed with water, and impregnated with a slight smell of sulphur; at others, there are collections of small fountains emitting only steam. The ground seems to tremble beneath the tread, and a low rumbling noise, like very distant thunder, is heard. The Great Geyser is on a mound of considerable extent, and there is a circular funnel or basin on the summit 4 feet deep, and averaging 54 feet in diameter, with a shaft or pipe at the bottom, which has a diameter of 10 or 12 feet a little below its junction with the basin. This shaft has been measured to the depth of 70 feet, where the water has a temperature of 260°; its sides, as well as those of the basin, are covered with a polished crust of siliceous matter. When an eruption is about to take place, water of the temperature of 180° or 190° rises through the pipe into the basin, the ground shakes, a rumbling noise is heard, and a column of water is projected into the air, frequently to the height of 80 or 100 feet. The basin often fills and overflows with water without an eruption. Another orifice is called the Roaring Geyser, from its continually emitting volumes of steam, and making a noise like the bellows of a blast furnace. A third one bears the name of the Shockr, or Shaker. Its mound is small; the basin is 8 feet in diameter at the mouth, and the depth of the well is 44 feet. Its surface is in constant ebullition, and it will occasionally project water nearly as high as the Great Geyser. The water contains a small quantity of sulphuretted hydrogen. A fourth, the Little Shockr, throws out, at intervals of twenty or thirty minutes, jets of water, which do not mount higher than 3 or 4 feet, accompanied by great clouds of steam and a roaring noise. On analysing the water of the Great Geyser, Faraday found in it a peculiar combination of silica and soda. On evaporating the water, the silica is deposited as an insoluble compound, and the soda is set free. We can thus account for the abundance of siliceous deposit at the fountain. Though the water is perfectly clear to the eye, every object suffered to lie in it for a few months becomes coated with silex. Sulphate and muriate of soda are also present. The specific gravity of the water was found to be 1000·8.

In Central America, also, there are volcanoes which eject boiling water.

The Geography of Ice.—The grand manufactories of ice are at the poles. Recent voyages have shown that there is land at the south pole, but at the north pole it is thought there is nothing but water, which, for eight months of the year, is frozen into a compact mass, forming a circle between 3000 and 4000 miles in diameter. When the warm season arrives, parts of this icy territory are detached, and are seen floating in warmer latitudes. They are known as *ice-fields* when their limits are too distant to be descried from the mast-head, *floes* when smaller. Both are usually covered with snow, and the former are occasionally 100 miles across. *Drift ice* is a quantity of sheet ice broken into variously sized pieces, but remaining near each other. *Bergs* are rugged broken masses, that project considerably above the surface of the water, generally terminating in peaks like a cliff, but having a great variety of shades. Icebergs are annually seen in the Northern Atlantic as far south as the fortieth parallel, and an ice-field was once seen as far south as the forty-fifth parallel. Bergs are occasionally seen as far as the Azores, and near the extremity of the Bank of Newfoundland, both in latitude 42° N. In the other hemisphere, however, they have come within a short distance of the Cape of Good Hope, between lat. 36° and 39°. Some of these rose nearly 300 feet above the sea, and one was 13 miles long, with vertical sides 100 feet high. Scoresby affirms, that for every cubic foot seen above, there must be at least eight cubic feet below water. In colder latitudes immense numbers of bergs may be seen within small spaces. Scoresby counted 500, between 100 and 200 feet high, drifting along in lat. 69° and 70° N. John Ross saw many bergs grounded in Baffin's Bay, in water 1500 feet deep. James Ross fell in with a chain of very large bergs, in close neighbourhood, that extended out of sight.

These bodies, when in shade, generally look like masses of chalk, and in the sun like refined sugar. Sometimes they are semitransparent, with a bluish or emerald green tinge.

Whilst the sea between Scotland, Norway, and Iceland, is always free from ice, the tract of water lying to the south-west of Iceland is frequently quite full of detached pieces. This is occasioned by a current called the great north polar current, which, originating in the vicinity of the pole, moves in a south-western direction, and brings down icy masses thrown off by the glaciers of Greenland, joins the current from Davis's Straits, and skirting the coast of Labrador, carries bergs into the centre of the Northern Atlantic, and into the neighbourhood of the Gulf stream. The meeting of these two streams, possessing such different temperatures, is the cause of the thick fogs that hang over the banks of Newfoundland. The polar current passes between the Gulf stream and the shore beyond Florida, and sends an under-current into the Caribbean Sea. This great current is subject to a periodical interruption, for in the vicinity of Cape Farewell (the southern point of Greenland) there is no perceptible movement between the middle of October and the middle of January.

A large iceberg in a warm latitude greatly affects both the water and the air. The water indicates a lower temperature for forty or fifty miles round, and the thermometer sinks 17° or 18° in their neighbourhood. The cold diffused over the American continent in Hudson's Bay, by the ice carried thither, is so great that, at the mouth of Hayes' River, lying in the same latitude as the south of Scotland, ice is found at the depth of four feet in the ground in the middle of summer.

Bergs and other forms of floating ice are frequently seen bearing rocks, stones, and mud; and it is the opinion of some, that most of the southern icebergs carry stones along with them, although usually concealed from view. Geologists point to this transporting power of ice as one of the means by which changes are slowly and silently wrought upon the earth's surface. The huge boulders which strew the plains of Tierra del Fuego and Patagonia on both sides of the Andes, are thought by Mr. Darwin to have been conveyed thither by icebergs.

The Antarctic Continent.—When the Antarctic continent was first seen by Sir James Ross (January 11, 1841), its general outline at once indicated that it was volcanic. It rose steeply from the ocean in a stupendous mountain range, peak above peak, enveloped in perpetual snow, and clustered together in groups resembling a vast mass of crystallization, which, when the sun's rays were thrown upon them, exhibited a scene of great magnificence. One remarkable peak, in shape like a huge crystal of quartz, rose to the height of 7,867 feet; another, thirty miles from the coast, to 9,096; and a third, to 8,444 feet above the level of the

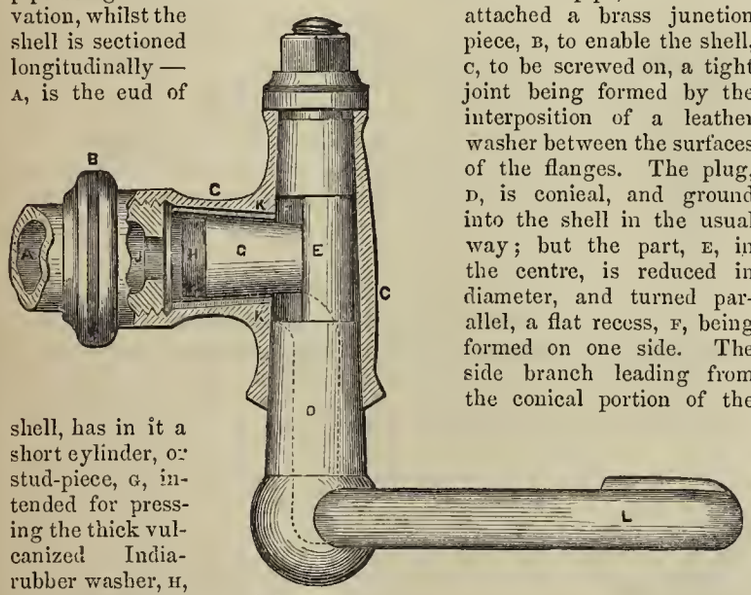
sea. From these peaks ridges descended to the coast, terminating abruptly in bold capes and promontories, whose steep escarpments, affording attachment to neither ice nor snow, showed the jet black lava or basalt beneath. In the same month a burning volcano (12,367 feet), afterwards named Mount Erebus, was discovered covered with ice and snow from base to summit. Flame and dense black smoke issued in jets from its apex to the height of 2,000 feet. An extinct volcano (10,884 feet) in the neighbourhood was named Mount Terror. On approaching the land it was found to be terminated by a perpendicular cliff of ice, between 100 and 200 feet high, perfectly flat on the top, and without any promontories or fissures. This vast barrier, which is probably 1000 feet thick, was traced eastward for about 300 miles in an unbroken line.

Land has also been discovered within the Antarctic circle by others, but whether it forms a part of Victoria continent is not known.

RENISON'S WATER SUPPLY STOP-COCK.

The defective action and irregular wear of the ordinary conical plug stop-cock under great pressure, is a matter of common complaint in domestic establishments, where the water supply is delivered upon the continuous gravitation pressure principle, now so universal. Under any circumstances, the cone with ground surfaces is an unmechanical and inefficient contrivance, and we are glad to see any attempts at the production of a substitute for it.

Messrs. Renison, of Union Street, Glasgow, have lately submitted to us a simple arrangement for this purpose, the principle and action of which will be made out from our engraving. It is represented as applied to the usual supply-pipe of the kitchen—the plug and discharge-pipe being in elevation, whilst the shell is sectioned longitudinally—



A, is the end of the water-pipe, to which is attached a brass junction piece, B, to enable the shell, C, to be screwed on, a tight joint being formed by the interposition of a leather washer between the surfaces of the flanges. The plug, D, is conical, and ground into the shell in the usual way; but the part, E, in the centre, is reduced in diameter, and turned parallel, a flat recess, F, being formed on one side. The side branch leading from the conical portion of the shell, has in it a short cylinder, or stud-piece, G, intended for pressing the thick vulcanized India-rubber washer, H, up against the face, I, of the piece, B.

Our drawing represents the cock as open—the water passing through the bore, J, of the junction piece, B, past the India-rubber washer, and through the two side passages cut longitudinally out of the thickness of the branch, at K K. These passages conduct the water into the space in the conical shell, left by the recess, F; and from this recess it finally escapes by an aperture in the side of the plug, D, into the tubular end of the latter, as indicated by the dotted lines, and is delivered by the curved branch tube, L, on the end of the plug. When the cock is to be closed, the depression of the branch, L, turns the plug, and brings round the solid portion, E, to bear against the end of the cylinder, G, and thus force the elastic washer, H, against its metal face, and stop the flow. To make the action smooth and easy, the junction of the flat bottom of the recess, F, with the cylindrical portion of the plug, is by well rounded curves, so that as the flat comes round, the end of the cylinder, G, is conducted smoothly on to the part, E.

Although the ground-plug is retained in this cock, it is to be remembered that the tightness of the valve is in no way dependent on that of the cone. The shutting-off of the fluid is confined entirely to the elastic washer, and it is only during the flow that the pressure comes upon the cone at all. Any foreign matter getting into the cock, will not necessarily impede the action of the valve, as the elastic face of the washer will adapt itself to any slight irregularities between the two faces. The closing being effected by direct pressure, there can be no frictional wear on these surfaces. The contrivance is simple, inexpensive, and easily fitted and adjusted.

WORKSHOP ECONOMICS.—SHIPTON'S NOISELESS BLOWING-FAN.—CARRETT'S PUMP-VALVE.

Messrs. Shipton & Co., of Manchester, have recently constructed, under the direction of Mr. Simpson, a "noiseless fan," which completely answers its intended purpose. Our engraving, fig. 1, represents the fan in plan, with one side of the case in horizontal section. The improvement is simply the addition of a projecting casing over the air-hole on each side, the air being drawn from some considerable distance, in place of taking it direct from the atmosphere surrounding the case. The holes in the casing to receive the shaft, were cast sufficiently large to allow of white metal bearings being run in when the shaft was duly adjusted. The fan is two feet in diameter, and is made pretty much according to Mr. Buckle's plan, as delineated at page 51 of our first volume.

Fig. 1.

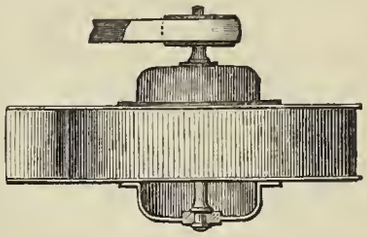


Fig. 2 exhibits a vertical section of a valve, which Mr. Carrett of Leeds has introduced in his new steam-pump; and fig. 3 is a plan of the valve. This valve has a clear thoroughfare, the tail-pin being only 1-8th inch thick in mid section, and the extra width required for guiding the valve in its seat is cut away where the water enters and departs, so that it offers no interruption to the discharge. It is, however, in the mode of placing the valve in its seat that its "economical" value more essentially consists. The valve-chest is not bored, nor is the seat turned outside, but is simply dropped into its place, and rammed round with cement, as at A. The valve and seat may thus be made of gun-metal, at the least possible cost; and their removal is easily effected, without impairing or removing the pump. For water, the joint of the cover is made with vulcanized India-rubber, as at B. Neither cover nor seat require turning, the elastic ring being pressed in such a manner that the greater the force of the water from within, the tighter the joint becomes. The plan presents a very considerable saving in the fitting up of pumps, inasmuch as by it, a rough casting is made as serviceable as one which has been turned and bored out. The valve is now being extensively introduced into locomotives, by Messrs. Wilson of Leeds. The "steam-pump" for which it was originally devised, will be described and illustrated in the *Practical Mechanic's Journal* for January next.

Fig. 2.

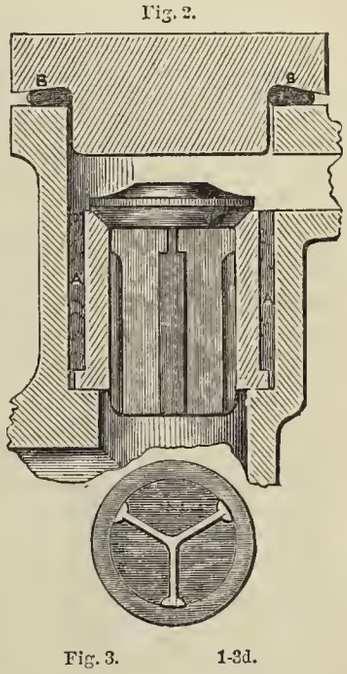


Fig. 3. 1-3d.

REFORM OF THE PATENT LAWS.

We have received the following regulation from the Attorney-General, as to the routine of the future proceedings in obtaining Reports in Patents:—

"The Attorney-General, with the assent and concurrence of the Solicitor-General, hereby gives notice, that every person applying for a Patent after the 2d of November inst., will be required to deposit, in the office of the Attorney-General, or Solicitor-General, an outline description, in writing or drawing, to be approved of by the Attorney or Solicitor-General, before any Report will be made on such Patent.

"*Lincoln's Inn, Nov.* 2, 1850. JOHN ROMILLY."

That this order has been issued by the Attorney-General with a view to the interests of inventors, and with a disregard of the additional labour imposed upon himself, is undoubted, but what the real effect will be, time only can tell.

Many of our readers will be aware that in cases of opposition to patents, the intending patentee has been hitherto compelled, not only to disclose to the Attorney or Solicitor-General what the object of his pro-

posed patent is, but also to deposit, in the Attorney or Solicitor General's office, an outline specification, in effect similar to that now compelled to be deposited in the office on all occasions. In such a case the understanding is, that the outline specification so deposited, is to contain the germ of the invention which the patentee, on coming to specify, six months after the date of his patent, can only amplify. He may not include anything intrinsically new or different from the specification so deposited, this being a measure necessary for the security of his opponent, when the Attorney-General has heard both parties state their inventions, and has decided that, the inventions not being conflicting, the applicant may obtain his patent. Without some such proceeding as we have described, the opposing party would gain no real advantage by his opposition. He must be guaranteed that the applicant will be bound down to his deposited particulars, as otherwise it might possibly occur, between the date of the report, and that of filing the specification, that the applicant would receive particulars of the opposing party's invention, and include it in his own specification. We say this is understood to be the case, but as no decision has ever been pronounced in the law courts upon this point, it may be considered as yet a moot question.

We are greatly amused at the remarks of a weekly contemporary upon this subject, who first puts forward the Attorney-General's order as the result of his own sagacious evidence before a Committee of the House of Commons, and then takes great pains to assure his readers that the regulation can be of no possible benefit, but may possibly leave them in a worse condition than it found them. One clear benefit seems to be gained by the new order, which we have not seen remarked upon elsewhere—that is, that a registrar of a design, under the Non-ornamental Act, has now a better chance of security.

Previously, cases have occurred where a design for an article of utility has been registered by one party, and four months afterwards a patentee, who had a title large enough to cover the invention, inserted a claim for it in his specification, it being held that the registration was utterly void, and the patent good. This arose entirely from the specification referring back to the date of the patent, which was, of course, anterior to the date of the registration, so that under the late system the security offered to a registrar of a design was very small indeed.

The question of Patent Law Reform, in connection with the forthcoming Exhibition, seems to be now exciting great interest, there being no fewer than three associations formed for the sole purpose of effecting its amendment in the metropolis alone.

With the exception of the one in connection with the Society of Arts, they do not appear, from the tone of their proceedngs, to be likely to be of much service in attaining the object they propose. The proceedings reported in the daily papers, of a deputation who waited upon the Board of Trade, seem rather calculated to throw ridicule upon the subject than to be of any assistance.

The value of patent property in this country has been so enormously enhanced of late years, that we are surprised its owners do not make some united demonstration to attain a better and safer means of attaining and holding their property. The expense of patents is not so much the subject matter to be complained of, as the uncertainty attending all proceedings in obtaining patents, and the fact that a patent can never be said to be actual property until its validity has been pronounced upon by a court of law. It is a field worthy of the attention of the association for promoting the amendment of the law, with Lord Brougham at their head —or of the Incorporated Law Society of the United Kingdom. If either of these societies were to take the matter in hand, we should hope for better results than seem likely to arise from any steps which have yet been taken for the purpose; but, unfortunately, the legal profession seem, as a body, to have abandoned the branch of the law relating to patents, to a body of men (with a few exceptions) utterly unqualified to protect the interests of inventors.

REGISTERED DESIGNS.

SMOKE ELEVATOR.

Registered for Messrs. E. O. & L. Tindall, *Scarborough, Yorkshire.*

This design is intended for the combined objects of the creation of an upward draught, and the prevention of downward blasts. Fig. 1 of our engravings represents the "elevator" in external elevation, and fig. 2 is a correspouding vertical section. It consists of a flue-tube, A, rectangular in section at the bottom, and gradually rounding into a cylinder, upwards. At the top of this tube is a fan-wheel, B, adjusted to revolve on a vertical steel spindle, resting on a flint as a footstep, contained in a short bottom tube filled with oil. The open top of the flue is covered with three blast protectors, C, set one above the other, leaving intervening spaces for the escape of the smoke, as shown by the arrows. At D, is a conical tube or case, open at top and bottom, to allow the blast to

Fig. 1.

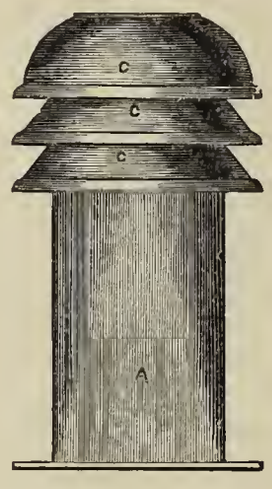
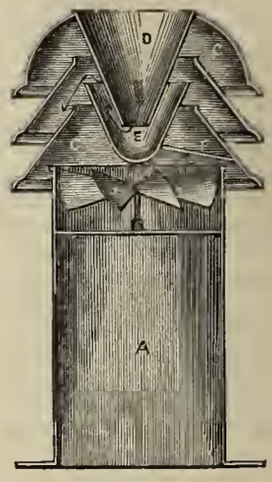


Fig. 2.



enter the second cone, E, closed at the bottom, and cleanse out the soot. The upper cone also acts as an exit for the smoke, whilst a little tube at F, lets off any water getting into the two cones.

The arrangement of the top completely prevents any down draughts, whilst it is peculiarly adapted for clearing away sooty deposits, so as to dispense with the necessity of sweeping. It has, besides, a very neat appearance, contrasting most favourably with the extraordinary forms which at present too frequently bristle on our house tops.

PORTABLE VAPOUR BATH.

Registered for Mr. W. Culverwell, *London.*

Mr. Culverwell quotes Drs. Combe and Hodgkin, in support of the use of vapour and hot air baths; and we may add our own favourable opinion as to the practical arrangement of the present ingenious contrivance, whereby the system is carried into effect.

Fig. 1.

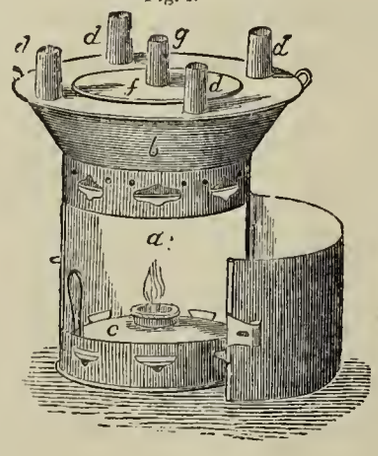


Fig. 2.

Fig. 3.

Fig. 4.

Our engravings represent the bath, with its lamp lighted for use, the door being open to show the internal arrangements, as in fig. 1. The case, *a*, is cylindrical, with a reservoir, *b*, in its head, to receive water or a medicated fluid, heated by the lamp, *c*. The flues through which the vapour rises are at *d*, and in fig. 2 is represented one of the caps, *e*, by means of which the vapour may be condensed if required. Fig. 3 represents, at *i*, one of the caps for promoting the generation of the vapour. The lid, *f*, has in it a flue, *g*, to which an elastic tube, *h*, fig. 4, may be attached for the purpose of directing the vapour to any part of the body. The baths are made both in tin and copper, at the price of a few shillings.

SAFETY MOUNT FOR FASTENINGS.

Registered for Mr. J. G. Taylor, *London.*

This is an ingenious improvement upon a well-known and useful clasp of French invention, used for securing the neat flat purses, which have lately become so universal. In the original plan of fastening, one clasp only being used, the projecting opening side is liable to catch and open accidentally in the pocket, and to avoid this, Mr. Taylor applies two clasps. Fig. 1 is a side view of a purse mount, half size; and fig. 2 is a corresponding edge view of the same, as fitted with the duplex clasp or fastener, A A. These two clasps are each hinged as usual at B B, facing each other, being made square at their point of junction, C, and brought flat down and close together, so as to afford no catching edge. When the two are shut down, they form a flush surface, and of course are both readily opened when necessary, whilst greater uniformity and neatness is given to the mount. Another feature is the forming each side of the mount with a flange, as shown in the edge view, fig. 2, so that any unfinished surface in the interior is hidden, instead of being laid open to view, as in the common bag-purse mounts. The joints of these mounts are formed by Mr. Taylor with duplex eyes, as at E E and F: a great improvement as well in neatness as in strength, upon the old-fashioned single eyes.

Fig. 1.

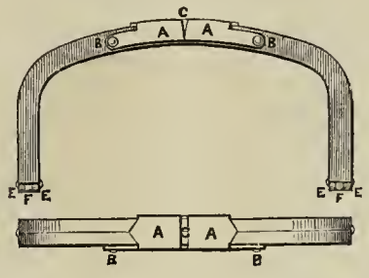
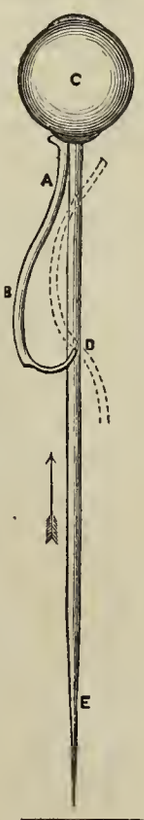


Fig. 2.

SELF-SECURING SPRING FOR PINS, BROOCHES, AND ORNAMENTS.

Registered for Mr. J. G. Taylor, *London.*

Mr. Taylor has provided, in this "self-securing spring," an excellent means of preventing the loss of such articles as are attached to the dress by pins. Our engraving exhibits a full-sized view of a lady's shawl pin fitted with the spring. A B, Is the holder, which is a piece of round spring metal, attached at one end, by soldering or otherwise, to the head of the pin, C, and curved outwards, terminating with a bend at D, the metal being at this part slightly flattened. The termination of the spring at D, has a little notch in it, to fit over the pin, E, upon which the spring rests when the pin is fastened in the dress. In attaching a pin thus fitted, it is not necessary to elevate the spring by hand, as when the point of the pin is entered into, and pushed through the dress, the pressure of the fabric in the direction of the arrow raises the spring, which again falls when the pin reappears through the material, and thus prevents the pin from accidentally falling out. The dotted line represents the line or section as it were of the dress, when the pin is fastened in, the end of the spring holding against the dress at B, and preventing the pin, E, from slipping out. We have seen pins made on this principle, and can vouch for the ease with which the self-securing action takes place in fastening, and the secure hold given to it when adjusted. The same arrangement is obviously applicable to various articles; and instead of being an unpleasant protuberance, the spring may be ornamented to give additional grace to the jewelled fastening.



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REVIEWS OF NEW BOOKS.

The Wages Calculator, showing the Value of Time per day and hour, from 1s. to 60s. per week. By Archibald Paton. Greenock: Mackenzie & Co. 1851.

A satisfactory shortener of arithmetical calculations, is one of the greatest helps to the counting-house operations of the man of commerce; and Mr. Paton's convenient little book may be safely recommended for its clearness of arrangement and comprehensiveness. As the title states, it ranges from 1s. to 60s. per week, the day being taken as ten hours long. Up to 5s. per day, the gradations of price are 1d.; from this rate to 60s., the ascending sum is 2d. A single page is devoted to each price, which is set across the top in bold characters, both the weekly and daily rate being given. The first vertical column refers to the days up to 24, and the first horizontal one gives the hours. The reference is then made after the fashion of the child's arithmetical card, the line of the amount being determined by the intersection of the day and hour columns; whilst the second vertical column carries the sum up to the nicety of the amount due for half an hour's work. At the end, a few pages are devoted to calculations of the value of cwts., qrs., and lbs., at rates varying from ¼*d.* per lb. to £392 per ton.

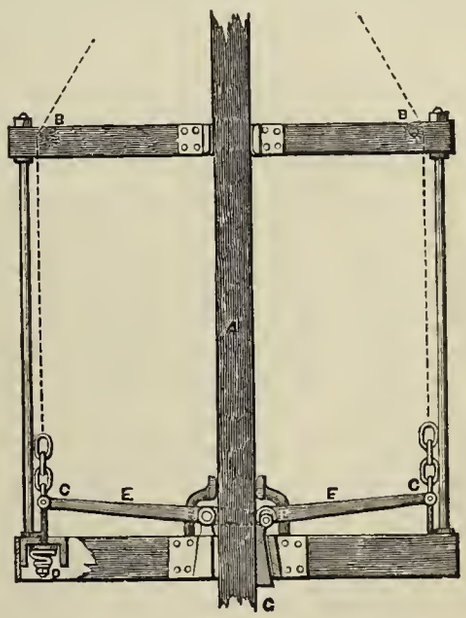
The author, in his official situation in the engineering works of Messrs. Caird & Co., has had his plan of ready reckoner under test for some years, and the facilities afforded by it have tempted many to adopt it, even in its manuscript state. To those whose calculations have reference to ten-hour days, the book will afford a great convenience.

CORRESPONDENCE.

SAFETY CAGE FOR MINES.

Having read an article in your Journal of last month, on some improvements in mining machinery, by Messrs White and Grant, I have sketched out, for your examination, a plan of safety apparatus which occurred to me some months ago, but has never been carried out.

The principle on which I have worked—is the assumption that it is not the actual insufficiency of the rope which causes fracture, but the repeated shocks or sudden tensional strains sustained each time the lift comes upon it. To obviate the injurious effects of this sudden action, I thought of adopting draw-springs, with the intent of bringing the tension gradually upon the rope.



Again, in case of accidental breakage, or the occurrence of overwinding, the draw-springs were to act upon levers and force wedges against the guides to sustain the cage, the latter of course being fitted with a detaching link. The outline sketch represents my proposed plan, in elevation, looking on the side of the cage guides, one only of which is seen at A. The two dotted lines represent the two cage chains, depending from the winding rope. These chains pass over guides at B, and are connected at C, with the spring links or tension rods of the volute springs, D, one of which is represented through the break in the cage platform. At C, the chains are also linked to the ends of a pair of levers, E, working on fixed centres at F, the opposite short arm of each lever being jointed to a holding wedge, G, one only being shown.

The cage is supposed to be loaded, the weight being upon the springs, D, and the wedges free, but should the rope fail, the reaction of these springs will draw down the long arms of the levers, and jam the wedges against the guides. The latter are made a little narrower at the top and bottom landings, in order that the spring may regain its position at each stoppage in readiness for the next movement.

Cherry Bank, Leith, Nov. 1850. John G. Winton.

ON STEAM BOILER EXPLOSIONS, AND SOME NEWLY-DISCOVERED PROPERTIES OF HEAT.

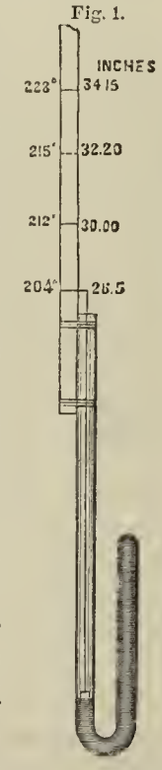
II.

As we stated at the commencement, we were not satisfied with any explanation that had then appeared, we endeavoured and have happily succeeded in discovering both an ample and hitherto unsuspected cause for the explosions of steam boilers. This discovery will be found valuable beyond calculation, and far beyond any of our previous expectations, for we have also discovered that explosions are not only occasioned by the sudden production of an unknown elastic fluid, a far more voluminous and energetic fluid than steam, which, however wonderful it may appear, may occasionally and suddenly be produced from the same quantity or equivalents of caloric and water; and what renders this discovery immensely valuable is the fact, that this new and superior elastic fluid, hitherto unknown to and unsuspected by chemists, may be far more easily and economically generated than steam, and employed with as perfect safety as steam, by a new, less expensive and far less cumbersome apparatus; hence it will be vastly more economical than steam, because motive force may be far more easily, cheaply and safely obtained thereby, thus exhibiting a distinct and new elementary compound, a far more voluminous and less expensive combination of fire and water, though of equal tension and mercantile value, which therefore, must become immensely more serviceable to mankind.

At the same time this discovery exposes one of the grossest mistakes and unfounded and astounding errors imaginable, first originated by those eminent chemical writers, Dr. Dalton and Gay-Lussac, since continually copied by others and by all writers on the steam engine, who advert to that particular subject, all of whom, with one exception, state, that when steam is heated out of contact with water, it is expanded at the same rate as atmospheric air or the gases, namely, $\frac{1}{480}$ part in volume by every additional degree of heat, or that its volume is doubled by 480 degrees of heat; while one learned exceptionist states, that by a more rigid and accurate experiment, a volume of steam, when so heated, is doubled by 460 degrees only!

Now our experiments have disclosed and our diagrams represent (all of which can be easily repeated and verified at little trouble and expense), that a volume of steam heated out of contact with water is doubled by the addition of about four degrees of heat, trebled by about sixteen degrees, and increased near tenfold by 440 degrees. Can any parallel be found for such an extreme absurdity as is here exhibited, between the mischievous theories that have been so long and pertinaciously propounded by many and most learned writers, and the plain facts we are about to disclose and substantiate by experiments and describe by sundry diagrams, all alike being delineated from a scale of one-half the dimensions from that by which the original instruments were constructed, and which instruments are thus faithfully represented on this diminished scale.

Fig. 1.



The present diagram represents a bent glass tube, sealed at the shorter end, a manometer or eudiometer, a very small drop of water having been first introduced into the shorter sealed end thereof, that end was filled with mercury, and such a certain small portion of the longer end (the exact quantity to be given hereafter). This eudiometer having a wooden handle, a cork float and index wire, covered with thread introduced therein, was prepared for experiment.

The shorter end of the eudiometer was immersed in a vessel of cold water, the vessel placed over a fire, and when the water boiled, small quantities of common salt were added at intervals, while the water was boiling, and until it was saturated and maintained the stationary heat of 228° for a few minutes, whereby the greater part of water being superfluous, was expelled with the mercury from the shorter to the longer end of tube without disturbance, and a full volume of pure steam, rarified and expanded by the heat of 228°, was retained in and filled the shorter end of tube, while the greatest height of the index wire was marked on the wooden handle.

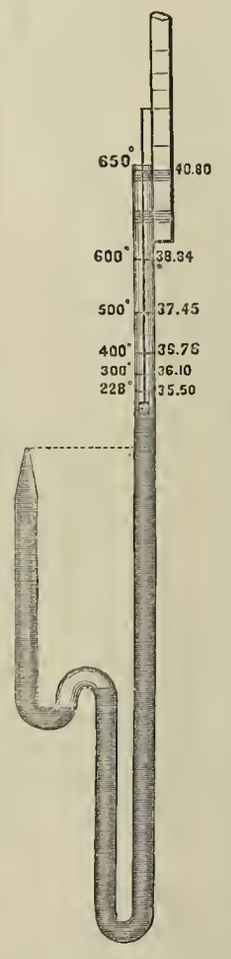
To estimate rightly the actual extent and value of the expansion of a definite volume of steam in this eudiometer, it becomes necessary, first, to define, obtain, and fix upon some well-known and definite unit of steam, and a volume of steam will be formed under atmospheric pressure and temperature 212°, which will faithfully represent a full and definite unit volume of atmospheric steam in the eudiometer, provided that, at the time of observation, the surface of the mercury in the shorter end of tube stands on a level with the mercury in the longer end of tube, both ends being immersed at the time in boiling water. This adjustment may be very conveniently and accurately obtained by employing a double boiler, or balneum Maria, the outer vessel of metal containing the boiling salt water, and an inner vessel of glass connected to a metallic bottom. Such a glass cylinder should be of much less diameter, but of twice the height of the outer metallic vessel, and filled with water, which will be maintained at the boiling temperature of 212°, by the greater heat of the saline solution at 228° in the outer vessel.

For in this transparent boiler and liquid, the quantity of mercury in the respective ends of the tube may be seen, the instrument may be withdrawn therefrom for adjustment, and very nicely adjusted and replaced. The index shows the different volumes of steam in the eudiometer due to the different temperatures of 212° and 228°, which being marked on the wooden handle, the intermediate volume at 216° may be readily obtained by a subsequent addition of such small quantities of salt to the fresh water bath, as will secure a fixed boiling temperature of 216° therein.

That diagram exhibits the unit of atmospheric steam accurately, and its apparent or visible increased expansion by heat, but not the real expansion, which being greater than the apparent, has still to be obtained by calculation, and by increasing the apparent in proportion to the increased densities of the steam, according to the well-known law of Mariotte, "that the volumes of all elastic fluids at the same temperatures are proportioned to their densities," and when that proper allowance has been made, the absolute expansion in the eudiometer will be found to correspond very nearly indeed with our previous general statement.

Having thus plainly shown the volume and rate of expansion of atmospheric steam, or of "low steam," when heated out of contact with water to 216° or to 228°, we will next show the rate of expansion of a unit of "high steam," or steam formed under pressure at 228°, when heated to 650° out of contact with water, by means of a definite unit of steam produced under greater pressure than the atmosphere, by a mercurial column contained within the doubly bent glass eudiometer, which at first is open at both ends, as represented in fig. 2. This instrument was prepared for experiment in the following manner. A small drop of water having been introduced within the upper doubly bent part, the instrument was filled with mercury to the level of the small taper and open end, and was then immersed (to nearly the level of the mercury within the instrument) into a vessel of cold water placed over a fire till the water boiled, when small quantities of salt being added at intervals till the water was saturated, and maintained the stationary heat of 228° for a quarter hour.

Fig.2.



By this means all the superfluous water and steam was gradually expelled from the doubly bent part of the tube, through and from the small open end, while the doubly bent part was filled with a volume of heated and rarified steam, produced under a temperature of 228°, and under the pressure of the atmosphere, = 30 inches + 5 inches mercury in the short tube, being a pressure equal to 35 inches mercury.

The eudiometer was then withdrawn from the saline bath, the steam condensed within the upper bent part and adhered to it. The instrument was then held in an inclined position, so that the included mercury filled the small taper end, and that end sealed with a blowpipe flame, the instrument was completed for experiment by equalizing the height of mercury in both ends of tube, by attaching a wooden handle thereto, and in introducing a float and index wire within the longer open end of the instrument.

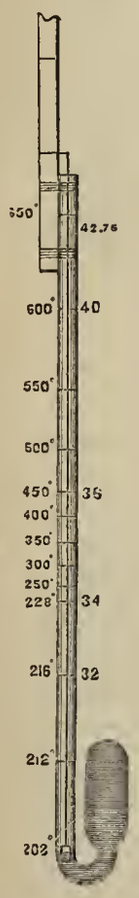
The experiment commenced by returning the instrument for a few minutes to the saline bath, heated to 228°, by which the definite volume of steam that had been obtained at that temperature was reproduced and defined by the index, and marked upon the handle. The second process consisted of transferring the eudiometer and a thermometer to a mercurial bath. This apparatus was heated to 650°, withdrawn from fire, allowed to cool leisurely, by which ample time was gained for correctly marking the corresponding descent of the mercury

in the instrument and thermometer, and marking the position of the index upon the handle (though transferred to the glass tube in the diagram, for want of room on the page).

Thus we show, by the aid of separate instruments, the nature and rate of expansion of steam, when heated in contact with mercury, but out of contact with water, from 212° to 228°, and from 228° to 650°.

The next diagram represents an instrument in which is shown the nature and rate of expansion of steam, when heated in contact with mercury and out of contact with water, from 208° to 650°.

Fig. 3.



The experiment commenced by introducing a small drop of water to the cylindrical bulb of the instrument, and then filling that bulb and such a probable small portion of the long tube as would cause the mercury to stand on a level in the bulb and long tube at 212°. The instrument being thus partially adjusted for experiment, was immersed along with a thermometer in a double mercurial bath, or balneum Maria, of considerable magnitude, while the temperature thereof was gradually raised to 650°, and maintained thereat some minutes, till the mercury was expelled from the cylindrical bulb, and all superfluous water and steam was expelled from the instrument.

The bath and included instruments being withdrawn from fire, were all alike allowed to cool spontaneously, which occupying more than an hour, afforded ample time for recording the corresponding descent of the mercury in both instruments, and which the diagram faithfully represents, as well as the calculated density of the steam at various periods, while the level of the mercury in the bulb and tube having been equalized at the temperature of 212°, to obtain the comparative unit of atmospheric steam therein.

To be able to make, repeat, and estimate correctly the advantages of these experiments, it will be first necessary to become acquainted with several facts first observed during these labours; and first, that mercury boils in a vacuum at about 570°, or 90° below its boiling point under atmospheric pressure; and, therefore, as it boils thus early in a well made thermometer, the sealed end of the instrument must be unsealed to obtain the requisite range of temperature.

Having, by the foregoing means, ascertained the great extent of the expansion of steam, when heated out of contact with water from 208° to 650°, and under pressure varying from 28 to 42·75 inches mercury, our next effort was directed to discover, by some easy and obvious means, the actual quantities of heat in natural steam and the relative quantities of heat or caloric in rarified steam when heated to 650° under atmospheric pressure, in order to learn the actual cost of each, and determine the relative mercantile value and economy of either, by the comparative quantities of heat required for their respective production, the only truly rational mode of comparison.

This important information was easily and distinctly ascertained, and may be readily verified, with little trouble or expense, by the use of a small and appropriate distilling apparatus. The one employed was connected by a small stop-cock with a high pressure steam-boiler, and the apparatus consisted of a small copper condenser, weighing three pounds, and having a superficial surface of two feet; it was placed at the bottom of a stout wooden covered cistern, containing half a cubic foot of cold water at 50°. Then as much water was occasionally distilled (from natural steam of various densities and corresponding temperatures) as exactly filled a glass measure with a narrow neck, containing nearly a pound of water; the half cubic foot of cold water in the cistern was heated thereby from 50° to 82°; therefore, 32° of heat had been separated from the measure of water obtained by distillation from natural or unheated steam. This exact quantity of heat, let it be particularly observed, was an invariable quantity, however various the temperature or density of the natural steam from which that constant measure of water was distilled; showing the curious and instructive fact, singularly needed long ago, yet hitherto unnamed and undefined by either chemical or philosophical writers, that *natural steam, however varying in density or temperature, is nevertheless one invariable atomic compound of water and caloric, and as definite as any chemical atomic compound whatever.*

This simple and wonderful fact, had it been plainly disclosed long ago, would have saved the world from the monstrous delusions that have so long vexed it, and misleading such men as Wolfe, Perkins, and others, who conceited that great profit would accrue from employing very high steam for motive power; while the fact plainly appears, that not a fraction of profit could thence alone possibly ensue, because the greater the tension of steam, the greater the proportional cost, the less the volume thereof. This notice may still be of use to any unfortunate who may still cherish any portion of the miserable delusion, by which, there can be no doubt, the rational improvement of the use of steam was thus irrationally and unnaturally hindered for many years.

Again, when a similar and exact measure of water was distilled by the same apparatus from steam heated to 650° out of contact with water, and in passing from the boiler to the condenser within and through a heated iron spiral tube, the cold water in the condensing cistern was heated from fifty to eighty-eight degrees, or thirty-eight degrees of heat was separated by distillation from the equal measure of water obtained from steam so subsequently heated to the temperature 650°.

Thus then it is clearly shown, that the whole heat in common steam of atmospheric tension, of any or every temperature, is to the whole heat in steam of equal tension heated to 650° out of contact with water, is 32 :: 38; or, the caloric therein is only about one-sixth part greater in quantity in heated and such greatly rarefied and expanded steam, than in common or natural steam.

By examining the diagram, No. 3, and scale annexed, it will be seen that a volume of atmospheric steam being heated to 650°, or 438° has been thereby and therein expanded to more than seven volumes, while the density thereof is at the same time increased in the proportion of 30 :: 42.50 inches mercury; the actual increase then, according to Mariotte's law, will be as 30 :: 42.50 :: 7 :: 9.8.

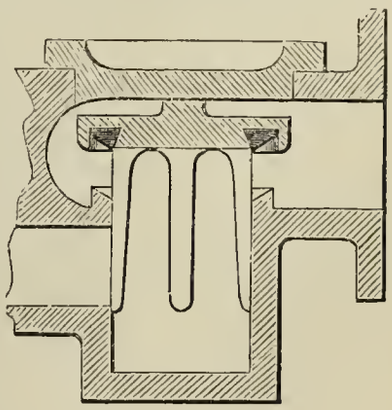
Having also seen by distillation, that the quantities of heat or caloric in expanded and in natural steam is as 38: 32, hence then as 38 :: 32 :: 9.8 :: 8.2 volumes of expanded steam that has been produced by the same quantity or equivalent of caloric required for the constitution of one volume only of natural steam of the same tension and mercantile value, and as these wonderfully distinct properties constitute it a chemically distinct and far more useful elastic fluid than steam, we propose to distinguish it, and to designate it by the convenient monosyllable "stame," instead of the more inconvenient, yet more truthful definition we have been able to arrive at, "subcharged steam," for if it were still to be called steam, as it contains but one-eighth the heat, and one-eighth the water in an equal volume of equal tension, it must most surely be considered as subcharged steam, and now when its distinct constitution is understood and substantiated, still to term it "surcharged" would be as puerile and unphilosophical, as to term steam surcharged water, or to term water surcharged ice, instead of appropriating a specific name to a specific object.

JAMES FROST.

Brooklyn, New York.

ELASTIC FACES FOR LIFT-VALVES.

I have been much pleased with the account of Mr. Humphrey's pump-valve, described and illustrated in the *Practical Mechanic's Journal* for November; but I think this class of valve might be further improved by turning a groove in the face, to be filled with vulcanized India-rubber, arranged to work upon an elevated seat. My sketch will explain what I mean. It represents a three-leg valve, like Mr. Humphrey's, with the face and seat in section. This form of face would answer excellently for safety-valves, as there would then be no danger of electric adhesion of the two surfaces, and the elastic substance answers perfectly for hot situations. During the last 25 years, I have fitted a great number of hydrostatic presses in this way, using leather for filling the grooves, and they have given every satisfaction.



Johnstone, November, 1850.

JOHN BRAIDWOOD.

INVENTORS—AND THE LAWS FOR THEIR PROTECTION.

The intended Industrial Exhibition of 1851 has naturally directed attention to the defective state of the law for the protection of designs and inventions; and on the principle that the first sufferers are the first to cry out when the shoe pinches, inventors who are unable or unwilling to procure letters patent for their inventions, are loudly complaining that no efficient protection has been provided for them by the Provisional Registration of Designs Act.

This act, as passed by the House of Lords, afforded the means of temporarily protecting not only those designs which are properly the subjects of registration, but also inventions which are protectable by letters patent; but the Commons (in the wisdom of hasty legislation, on a subject of which they were ignorant), sapiently excluded the provision by which patentable inventions might be provisionally registered, leaving the unlucky inventors in their original position—*i. e.*, unable to secure their inventions, even for the obviously too short period of one year, without the expense of some three or four hundred pounds.

The first to suffer are the first to complain, but in this instance the first sufferers, *i. e.*, the inventors, are by no means the greatest sufferers. There is another sufferer, yclept John Bull, or rather the whole of the more civilized inhabitants of the earth, who are ultimately the greatest sufferers. The inventor loses the chance of remuneration—perhaps of fortune—but all the advantages he reaps from a successful invention are small to its advantages to society at large. Witness the plough, which has been in use thousands of years—Watt's improvements on steam-engines—gas-lighting—steam locomotion, by land and water—the electric telegraph—spinning and weaving by mechanical means, and the numerous other inventions which have influenced human progress. Society reaps the great benefit, ergo society has the strongest interest, that inventions and improvements should be published; but society can hardly expect inventors to publish, unless inventors can retain the property of their invention after publication, at least for a much longer period than one year.

I have already suggested a remedy for this evil, namely, to grant letters patent without stamp tax or office fees; but 'John Bull' has been paying taxes and fees "pretty considerable" from time immemorial, and does not seem to relish the idea of having his rights without paying extra. It is true, taxes are imposed to cover the expense of the administration of the laws; but Mr. Bull hardly yet perceives that the prepayment of taxes affords him an equitable claim to the protection of his scientific, as well as his literary property. It is not the characteristic of the animal, yclept 'John Bull,' readily to perceive logical interences. As complete justice seems hopeless, on the principle professed by the late Daniel O'Connell, that ten shillings in the pound is better than no dividend, I would suggest the following compromise between our right to have our scientific property protected without extra charge, and the practice of selling justice (very dear) which has prevailed hitherto:—

That a patent right be granted for three years—on application, accompanied with an outline of the specification—without stamp tax or fees, the patentee to have the liberty to make and sell the thing patented; after which period of time he shall be subjected to a charge of £5 per annum, for the remaining term of the patent—neglecting to pay the annual tax, to incur the forfeiture of the patent right. This plan appears to possess the following advantages:—

1st. It affords the inventor the means of immediately obtaining a moderately limited property in his invention, with the smallest possible cost; that is, only that of the specification.

2d. Of making the requisite experiments to perfect his invention, without the risk of piracy.

3d. It makes the inventor pay something—this seems a *sine quâ non*. I cannot get any one to support the suggestion of doing equal justice to inventors and literary authors, by giving a copyright without charge to the former; it seems agreed that any one guilty of the crime of being an inventor shall be made to pay extra for the protection of his scientific property. I do not see the logic, but I must bend to prejudice, or cease to be practical.

4th. Of ascertaining if the public are likely to buy the thing patented, and consequently of its being likely to be worth the cost of obtaining an extension of the term of patent right beyond the first three years, by the annual payment of £5. Provisional registration, without the right to sell the thing registered, is so far deficient that it would not enable the inventor to ascertain if the public would buy the thing registered, and the invention be commercially advantagous.

5th. As the patentee can at any time determine the patent by ceasing the annual payment, inventions which are not worth working would not long continue to be obstacles to the progress of improvement. This is a great evil at present, and its magnitude would be increased if patents could be obtained without cost, unless my proposal be adopted to compel patentees, under some circumstances, to grant licences, (see the *Patent Journal*, No. 168, August 11, 1849, page 189,) so as to prevent the patentees from using their patent rights in a manner to become a public nuisance.

6th. This plan does not make the unsuccessful inventor pay for his misfortune of producing a worthless invention; at least, he need not continue paying longer than he pleases, and need not pay at all if satisfied with the three years' trial.

7th. The sum of £5 per annum is selected in accordance with the recommendation of the Committee of Privy Council, that the total charge should be about £50. Five pounds, paid for eleven years, amounts to about the sum recommended.

8th. The number of patents at one time would not be so inconveniently great as if all patents were granted for the full term—the worthless ones would die a natural death from the cessation of the £5 annual sustenance required to keep them alive.

9th. It insures that almost all the numerous valuable inventions which are now concealed in consequence of their inventors being unwilling or unable to patent them, will be published, and the public no longer deprived of the advantages which will result from their use.

In my humble opinion the latter is by far the most important consideration: whether inventors thrive or perish is of less moment than the question—Shall society progress in civilization at the geometrical ratio which will result from lifting the veil of Isis from the good inventions concealed; or go on at the present comparatively slow rate which is the natural punishment of our unjust treatment of the seething minds, which by the law of their nature, work good for us in secret, which we prevent the publication of by our unjust and consequently impolitic laws.

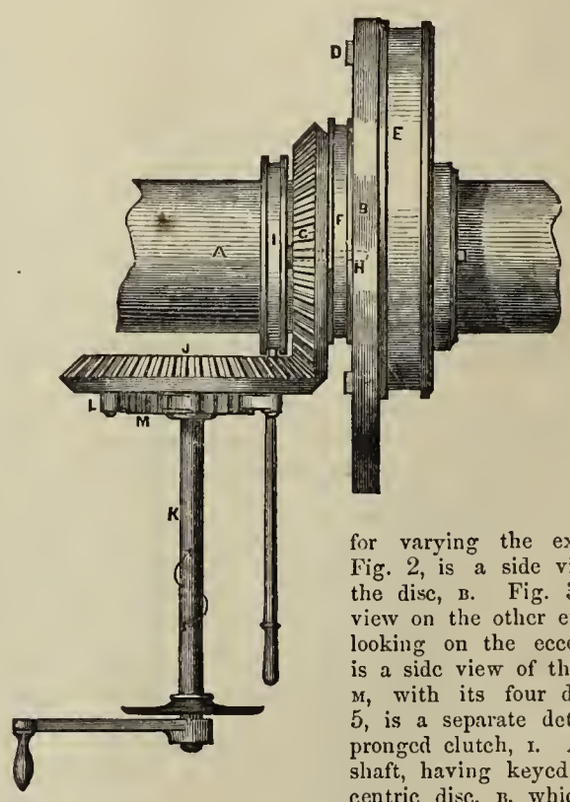
ALFRED SAVAGE.

London, Nov. 1850.

DUPLEX ECCENTRIC EXPANSION GEAR.

The subject of the expansive action of steam, is now deservedly engaging a very large share of the attention of the practical engineer; I may, therefore, without apology, offer to your attention an eccentric arrangement for expansive working, as delineated in the annexed sketches. The contrivance acts in the same manner as Dodd's wedge-motion; and any required amount of travel may be given by it to the valve, without altering the "lead" in the least. Fig. 1, represents a portion of a crank-shaft, showing an edge view of the eccentrics, together with the hand-gear for varying the expansive action. Fig. 2, is a side view, looking on the disc, B. Fig. 3, is a similar view on the other end of the shaft, looking on the eccentric. Fig. 4, is a side view of the ratchet-wheel, M, with its four detents; and fig. 5, is a separate detail of the two-pronged clutch, I. A, is the crank-shaft, having keyed upon it a concentric disc, B, which is slotted in four places, as C C, to receive the four projections, D, of the large eccentric, E. This eccentric is simply a ring, as shown in fig. 3. Two of its projections are bolted to the strap of the small eccentric, F, which is cast in one piece with the bevil-wheel, G, loose on the crank-shaft.

Fig. 1.

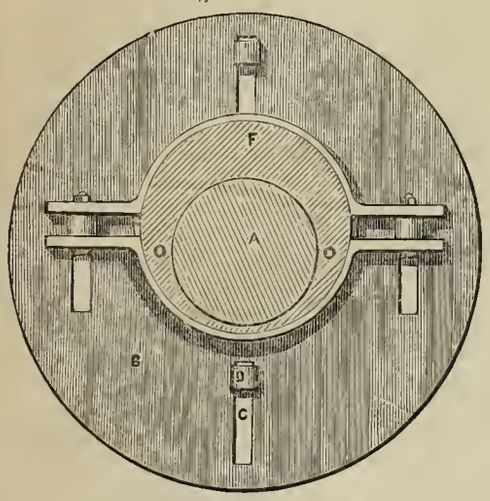


Scale 1-10th.

Two holes are made in the wheel and eccentric to receive the pins, H, of the clutch, I; which pins pass through and enter corresponding holes in the back of the disc, B. The wheel, G, is driven by the corresponding wheel, J, loose on the shaft, K, and has four detents, L, set on its back, to gear with the ratchet-wheel, M, fast on the shaft. This shaft is actuated by the winch-handle on its end, where there is an index and

hand to indicate the state of the expansion. In the sketch, the eccentric, E, is shown at full throw; but if it is necessary to shorten the throw, the requisite movement is accomplished by disengaging the clutch-pins, H, from the disc, B, and turning the winch-handle in the direction of the arrow. The detents, L, then catch in the wheel, M, and in this way motion is communicated through the wheel, G, to the eccentric, F, obviously causing the projections, D, to slide in their slots, bringing the large eccentric, E, more nearly concentric with the centre of the shaft.

Fig. 2.



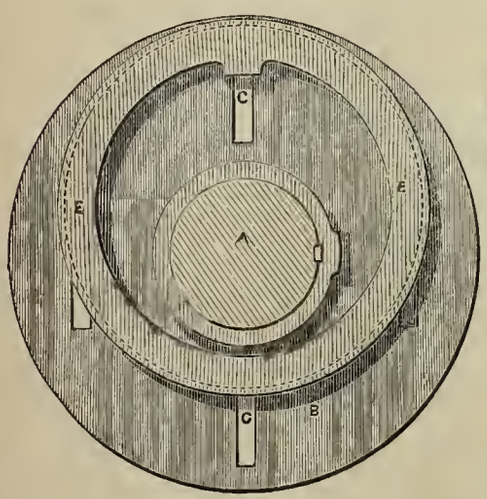
Scale 1-16th.

A simpler form of this apparatus, applicable to engines where the work is subject to little variation, is represented in figs. 6 and 7. A, is the crank-shaft, carrying a slotted disc, B, as before, to receive the projections, C, of the eccentric, D. One of these projections, as at c', is formed to answer as a nut for the adjusting screw, E, the revolution of which communicates more or less throw to the eccentric. D, as in the first modification. At the back of one of the slots a scale is placed, to show the state of the expansion. It will be seen that this arrangement is considerably simpler than the first, but is more limited in its application.

J. R. Y.

Glasgow, November, 1850.

Fig. 3.



Scale 1-16th.

Fig. 4.

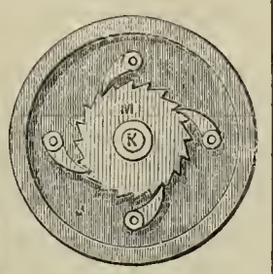


Fig. 5.

Fig. 6.

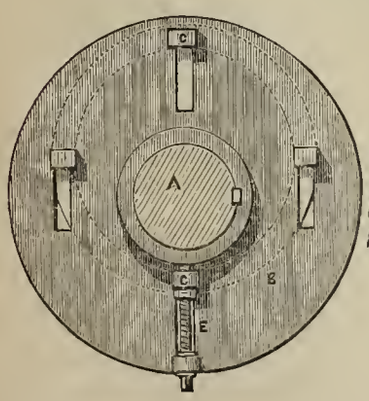
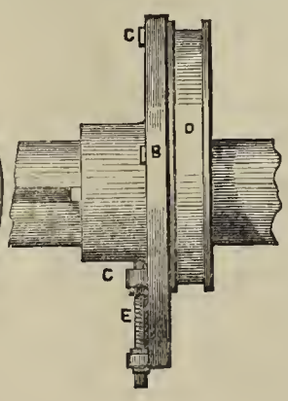


Fig. 7.



THE "NIAGARA" THROSTLE.

It is refreshing to find you spare a corner of the Journal, now and then, for the elucidation of something new, or for improvements, connected with our textile manufactures.

Your last month's "Contribution to the history of cotton-spinning," is something in a direction in which a numerous class of your admirers would like to find you oftener drawing their attention. Without giving any opinion on the merits of the "contribution," permit me to call your attention to a defect in the principle of twisting yarns by the bobbin alone, and without the aid of the flyer.

The defect is that the yarn will get *more twist* when the bobbin is full than when it is empty, and we can suppose a case where the yarns would get no twist at all; in fact, in certain conditions the bobbin would actually not take up the yarn so fast as it is delivered by the roller.

Take an example: Let the circumference of the drawing roller be 3 inches, speed 100, and let the circumference of the bobbin be 3 inches, speed 100; it is clear in the above case that the yarns could get no twist, and the traveller would not need to travel any, but would merely act as a guide to build the yarn—twistless—on the bobbin. Again, suppose in actual practice, that the yarn requires 10 twists per inch, $10 \times 3 = 30$ revolutions of bobbin for one of drawing roller, the bobbin being, as above, 3 inches in circumference, then it is clear that the yarn will not get 10 twists per inch, but 29 twists in 3 inches, or $9\frac{2}{3}$ twists per inch.

R. D.

Blairgowrie, November, 1850.

PARKER'S WATER-WHEEL.

I see that a correspondent in the May number of the *Franklin Journal*, takes notice of a few observations which I sent you, relating to Parker's water-wheel, and published in the *Practical Mechanic's Journal* for March. The writer, after quoting the statement relating to the invention of the wheel, says, "Then follows a short piece of that coarse abuse, in which British periodicals used to be in the habit of indulging towards Americans." I am very sure that what I said, could not be construed into "coarse abuse" by any one who understands the English language. Mr. "F." must be one of those morbidly sensitive folks, who cannot bear even a delicate hint at their failings. But to the point of the question, Colonel Morin, in the Comptes Rendus de l'Académie des Sciences, tome 22d, claims for Jouval the invention of placing the turbine at the top of the fall, and the adoption of the air-tight tube. The earliest notice that I can obtain of this invention, is dated October 27, 1841. I shall, however, write to the Messrs. Koechlin to ascertain the date of Jouval's invention, as the patent was afterwards sold to them. I shall then let you know the result. I may state that in the most improved form of the turbine, the axis is vertical; if F. thinks that Austin & Zebulon Parker are entitled to any credit for making the axis of their wheel horizontal, they are welcome to it; it would be very easy to show that there must be a loss of power by their mode.

J. G.

Glasgow, November, 1850.

SCREW PRESSES FOR COTTON.

In the October number of your magazine, you give engravings of Hunter's differential screw, as applied to a letter copying press, stating that it is also applied to cotton presses. If you, or any of your correspondents, can furnish a sketch or description of the principal parts and mode of applying manual power to such presses as are used in East India, you will oblige,

φ.

Glasgow, November, 1850.

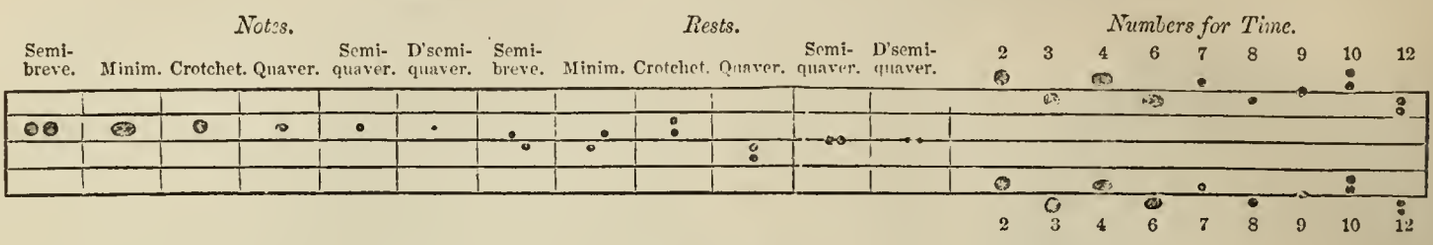
WIRE ROPE SIGNALS FOR RAILWAYS.

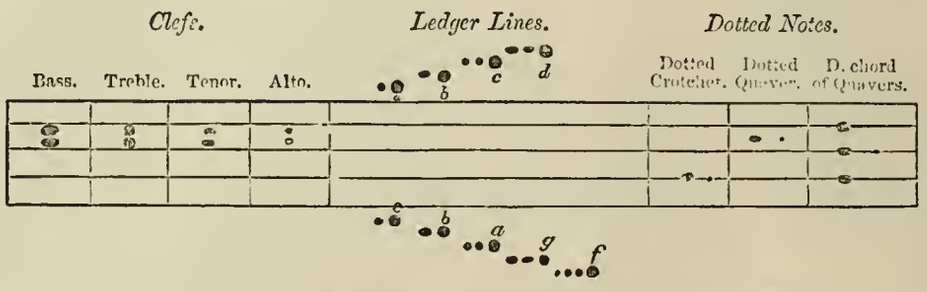
My attention has been called to the inquiry of one of your Parisian correspondents, who wishes to know who is the inventor of these signals, and if patented in England. I now answer him, that, in the year 1846, I exhibited a large-sized model of the invention before Prince Albert, at the Marquis of Northampton's mansion in Piccadilly, where were assembled many of the nobles of the land, and the *élite* of scientific men, at a conversazione of the Royal Society. I am sorry to find so many of the railway directors, and other officials, who countenance their servants in appropriating the inventions of others.

R. Rettie.

Edinburgh, November, 1850.

MANUSCRIPT MUSIC NOTATION FOR THE BLIND.





Some time age I sent you a simple method of arithmetic notation for the blind, by means of pins and a pincushion. I now send you the same idea as applied to music, by means of which any blind person can copy a piece of music for themselves, and read it by their fingers.

The whole of the characters in music, whether notes, numbers, rests, &c., are represented by common pins, having five differently shaped heads, stuck into a pincushion, which has raised cords run through it, representing the staves. In the drawing, the lines are the raised cords of the pincushion, and the dots are the pins placed in their various positions. The values of the notes are determined by the shape of the pin, without regard to position. The semibreve is made with two large round pins placed close to each other, thus ( ); the minim with one large flat pin, thus ( ); the crotchet with one large round pin ( ); the quaver with one small flat pin ( ); the semiquaver with one middle-sized round pin ( ); and the demisemiquaver with the smallest round pin (·). The rests are made with the middle-sized round pin, and are distinguished by their position in relation to the middle line of the stave; by referring to the drawing their positions and value will be at once seen. The numbers for the time are made with the large round, the large flat, and the middle-sized round pin, placed in relation to the upper line of the stave, and also the same numbers in relation to the lower line, as it is necessary to have a *double* set of numbers; thus, 2 may either be written so or so The following symbol would be By referring to the double numbers in the drawing, this will be more easily understood. Common time, as it frequently occurs, is made by placing two large round pins vertically over the top lines. The clefs are made by placing two pins vertically in the third space. The large flat pins representing the bass clef, the large round, the treble, and so on. The signs for the various keys are made by large round pins for the sharps, and large flat pins for the flats, using as many pins as there are sharps or flats; thus, three round pins stand for three sharps, and four large flat pins would be four flats, and so on. Accidental sharps, flats, or naturals, are made by placing a large round pin for a sharp, and a large flat pin for a flat, or a small flat pin for a natural, to the *right* of the note to be sharpened or flattened; thus, in this chord of crotchets A is sharpened, or in this chord of quavers B is flattened. The notes above and below the stave are made by placing small pins to the *left* of the note, using an additional pin for each additional stroke. The small round pin is employed to indicate notes on the lines, and the small flat pin the notes on the spaces; by referring to the drawing these will be seen at a glance. Dots are made by placing the smallest round pin to the right of the note; for chords, instead of dotting every note, it is quite sufficient to dot only one, as shown in the drawing. The symbol for playing an octave higher is made by three middle sized round pins, in the form of a triangle, on the top of the stave placing one symbol over the note where it commences, and another where it ends. Shakes are made by placing two of the smallest pins close to each other, over the note to be shaken. The lines for bars are made by long pieces of wire stretching across the stave.

EXPLANATION.—This mark ( ) represents the large round pin, this ( ) the large flat pin, this ( ) the small round, this ( ) the small flat, and this (·) the smallest round pin.

Note.—As the symbols for accidental sharps, flats, and naturals, are liable to be confounded with some of the notes above and below the stave, this general rule must be attended to: the pins for the latter should be placed *close* to each other, all the others at a little distance, say a pin's breadth. The same rule is to be applied to the semibreve, the symbol for which would otherwise be mistaken for a crotchet with a sharp to it. The pins should be thrust into the cushion up to the head.

ROBERT FOULIS, M.D.

124 *Princes Street, Edinburgh.*

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—TWENTIETH MEETING.—EDINBURGH, AUGUST 1, 1850.

SECTION B.—CHEMISTRY, INCLUDING ITS APPLICATIONS TO AGRICULTURE AND THE ARTS.

"On the action of the Soap Test upon Water containing a salt of magnesia only, and likewise upon water containing a salt of magnesia and a salt of lime," by Mr. D. Campbell.

This was an examination of the value of the soap test of Dr. Clarke. The conclusions arrived at were—1st. That water containing sulphate of magnesia alone, acts towards the soap test in producing with it a perfect lather, similarly, or nearly so, as does water containing a lime salt alone,—but only when the equivalent of magnesia salt does not exceed six grains of carbonate of lime in a gallon of water.—2d. That the degrees of hardness of an ordinary water cannot be inferred by the rule. Compute the grains of lime, magnesia, oxides of iron and alumina, in a gallon of water, each into its equivalent of chalk. The sum of these equivalents will be the hardness of the water.—3d. That the degrees of hardness of a water containing magnesia and lime salts, as shown by the soap test as it is now applied, cannot in every case be taken as representing the amount of these salts in the water; nor in nearly any instance can it be considered as giving the amount of lime in a water when magnesia is present.—4th. That water might show by the soap test a small degree of hardness in comparison to the considerable quantities of salts of magnesia, and of lime it might contain; and trusting to this method of analysis alone, when selecting water for ordinary use, and for steam purposes, might lead to a water being adopted which might not be conducive to the general health, and which would leave considerable deposit in vessels in which it was boiled—a great deterioration to its use in steam-generating.

Section G.—Mechanical Science.

"On the Dynamic Equivalent of Current Electricity, and on a fixed scale for Electromotive Force in Galvanometry," by Mr. W. Petrie.

The dynamic value of a current of voltaic electricity is represented by the product of the rate at which electro-chemical action is taking place at any cross section of the current, (in other words, the quantity of the current), and the electromotive force with which the current is sustained, which may be termed its energy or intensity, (provided the idea of quantity be kept distinct from this.) The first object was to secure such units of comparison for both these elements as should be at all times recoverable. This is given in respect of quantity by the rate of chemical action, and the atomic weights. In respect of intensity of the current, we have no such fixed data, and the intensity of most voltaic arrangements cannot be relied on as constants for comparison. But the elements of Daniell's Battery, and those of nitric acid batteries, with negative surface of platinum, carbon, or cast iron, give an electromotive force or intensity that can be recovered with considerable exactitude, if uniformity of circumstances, materials, &c. be tolerably attended to: these, therefore, may be used to give a fixed and recoverable point in a galvanometric scale of intensity. Now, it so happens, that if we assume the degrees of the scale to be of such a size that the intensity of Daniell's (standard) elements shall be 60 of the degrees, temperature being 700 Fabr.—that of mere acid batteries being from 110 to 112 of the same degrees; the author, therefore, has always used this scale, to which all other voltaic arrangements can be referred. Which scale, he would suggest, would be most conveniently used in assigning the electromotive power of electric currents from any source. The mean result of careful experiments, tried directly and conversely, is that a voltaic current of one unit in quantity, (or that from one grain of zinc electro-oxidised per minute) and of 100 degrees intensity, represents a dynamic force of 302½ pounds raised one foot high per minute. This datum is of great interest as a scientific truth in connection with the other correlative agents of nature, (heat, electricity, light, and chemical affinities, neuralgic power, &c.), most of which we may hope soon to see reduced to a mutually comparable relation to each other, in terms of the great centre and medium of comparison, mechanical force. This paper was accompanied by a table of the relative and absolute powers of electro-motors.

"On the Dynactinometer," by Mr. Claudet.

In the introductory portion, the author insisted on the great importance of distinguishing between the optical foci of the lenses used in photographic cameras and the foci of the photogenic rays. He said that ignorance of this distinction, or inattention to it, was the source of one of the greatest defects in photographic pictures. He had invented a simple instrument, which was exhibited and explained, for accurately distancing the object to be depicted and determining the corresponding foci of the photogenic rays, in any given camera. It consisted of a number of marked sectors arranged in a spiral order at several equal distances along a cylinder supported in a frame. By placing this before a photographic camera, the sector of which the image was most distinct could be at once seen, and this determined the distance at which the object should be placed in front of the camera. Since he had invented this, he had found that there was a proper time for exposing an object on a given day, and under given circumstances, before the camera; and that a longer or a shorter time than this was injurious to the effect. To ascertain readily this proper time, he had invented the dynactinometer, which he now exhibited. It consisted of a square frame of card, with a circle of card capable of being turned round either by hand or by clock-work; in one position of this circle the whole surface of the frame exposed to the camera at the proper photogenic distance was black; but as the circle turned a neatly divided sector of white card was exposed, and by causing the circle to turn so as to expose a given number of divisions each successive equal number of seconds, the part of the sector whose image was most clearly defined on examination of the photogenic drawing, gave the number of seconds best for exposing the object to the camera. But as the several photogenic plates were not all equally sensitive, the sensitiveness of the plates was determined by placing them in a small frame, and allowing them to descend along an inclined plane, during a certain part of which descent small circular spots were exposed to the action of light, the rest being quite protected. The action of the light on these spots gave a ready and exact means of comparing the sensitiveness of the several plates.

Professor Stevelly attempted to explain the occasional distinct vision of rapidly revolving coloured sectors. He exhibited an instrument for whirling cards with coloured sectors on them, devised by Mr. Grattan, of Belfast, to teach his children the effect of combining colours. He had shown this at the Natural History Society with an application for enabling painters to determine, experimentally, the exact mixture of any number of colours, and their relative proportion to produce the exact effect which they required. This apparatus he had lent to Professor Stevelly to show his class; and while doing so he was surprised to observe that while the cards were revolving rapidly, if he suddenly turned away his head he caught a distinct view of the individual coloured sectors at the instant he was losing sight of them by a side view. A few weeks before this he had attended the lectures of Professor Carlisle, of the Queen's College, Belfast, on the anatomy of the eye and of the ear; and had then become acquainted with a fact connected with the arrangement of the optic nerves and their relation to the retina, which seemed to him to afford an explanation of this curious fact. The optic nerve which originated in the right side of the brain, crossed over to the left eye, but on entering that eyeball only spread out into that part of the retina which spread over the portion of the eyeball next the nose; and the similar portion of the retina of the right eye was supplied by the optic nerve which sprang from the left side of the brain. These nerves, however, were united in their action by a commissure nerve, which stretched in an arch from the one to the other. The other and larger portion of the retina of each eye, and that on which the images of objects as usually seen were depicted, was formed by nerves which sprang from the brain in each case on the side next the eye to which they went; these, after accompanying the optic nerve of the other eye to the place where it crossed the optic nerve going to its own eye, turned round with a bend and accompanied it in its passage into the eyeball. These portions of the retina of the different eyes, were also united into one nervous action by the "commissure of the retina." So that, the retina of each eye was divided into two portions,—the portion next the nose, and the outer and larger portion; and these two portions of each eye were supplied by nerves springing from opposite sides of the brain, and not united in their action by any commissure or connecting nerve. Now, the consequence of the sudden turn of the head was, to throw the image from its usual place on to the portion of the retina next the nose, affecting a new and fresh part of the retina for an instant only,—for the motion of the head instantly interposed the socket of the eye, and shut off the object. The sectors therefore became distinct at that instant, for a similar reason that in the beautiful experiment of Professor Wheatstone, the electric spark showed them distinct,—viz. the instantaneousness of the impression.

Sir D. Brewster said that the crossing of the optic nerves had been known to Sir Isaac Newton, and a description of the arrangement of the nerves had been found among his papers, and since published. As to the commissure or connecting nerves, he was not so clear about them; but he would consider the entire explanation.—Professor Forbes said, that as to assisting painters in producing the effect which they might desire by blending of colours by motion, he feared that in some cases this would not answer. For example, he never could by whirling any combination of blue and yellow papers produce a good green, though it was well known that painters by mixing these colours could produce that colour in all its shades.—Sir D. Brewster said the reason of this was, that the blues and yellows of coloured paper were themselves very compound colours, containing usually a very large proportion of red in their composition.

INSTITUTION OF CIVIL ENGINEERS.

November 12, 1850.

William Cubitt, Esq., President, in the Chair.

"On a comparative View of the recorded Explosions in Coal Mines," by Mr. Wm. West, (of Leeds), Assoc. Inst. C.E.

The reports of Faraday, Lyell, De la Beche, Playfair, and others, were carefully analyzed and tabulated, from which it appeared, that tendencies towards a dangerous condition existed in mines reputed to be comparatively safe, and that these tendencies were so numerous, and varied so suddenly in their nature and extent, as to necessitate attention to every kind of precaution.

The proposed appointment, by the Government, of inspectors of mines, was noticed, not with the intention of showing that their supervision would diminish the responsibility of the mining engineers and overmen, but of demonstrating, that by establishing more constant communication between the various districts, they might induce the general adoption of those measures of precaution which were found in certain mines to be so efficacious in averting accidents, or in affording means of safety when they did occur.

The different depths of mines, varying from seventy-five yards at Darley, to three hundred yards at Haswell, did not appear to have any influence on the accidents. The tendency to the emission of carburetted hydrogen gas from certain seams, would have appeared a more rational reason, though the records did not appear to bear out that theory, as mines receiving a tolerable character had been the scene of repeated explosions; for instance, the Jarrow Mine, where, although reported "to be not very fiery," there had been six explosions in the course of twenty-eight years, and one hundred and forty persons had been killed.

The compatibility of general good ventilation, with the occasional occurrence of the most fatal explosions, was particularly dwelt on. The witnesses on the inquests after the Haswell and the Jarrow accidents, agreed that the "ventilation was perfect," "the pit full of air," "the air quite good, and plenty of it." The fault, then, did not lie in the quantity of air, but rather in the difficulty of directing it so generally throughout all parts of the mine, as to sweep away the gas as it was produced. The "splits" for the air were noticed, and the condition of the goaf, the pockets of gas formed in the roof, and the sudden irruptions from the occasional falls in the goaf and old stalls, were dwelt on at great length, and, combined with the injudicious use of unprotected lights, and the liability of accident to the lamps, were shown to have been the probable cause of all the explosions. The miners' lamps were passed over somewhat too cursorily, as at the present moment, when so much has been done for their improvement, that part of the subject might have been descanted on with advantage.

The precautions for saving life on the occurrence of accidents, such as abolishing bratticed shafts, and sinking a pair at each mine, at such distances apart as should insure one remaining intact, in case of an explosion injuring the other; the "scaling off" of a portion of the fresh air for the exhausting furnace, and conducting the return air into the upcast shaft at some height above the fire; together with several minor details for insuring the constant working of the exhausting apparatus, to draw off the fatal "after-damp, or choke-damp," were strongly insisted on.

The rashness and carelessness of the miners was instanced with regret; but it was shown that by education and good example, their better qualities must be brought out, and that then, the best safeguard against accident, would be the instinctive love of life, and a knowledge of impending danger from the infringement of any of the precautionary regulations established in the mines. The improvement of the workmen was, therefore, strongly insisted on, as more real benefit would probably result from such measures, than from the appointment of a host of Government Inspectors.

The Paper was illustrated by large diagrams of the author's views of the forms of "Goaf Hollows," and "Goaf Basins," as well as by several plans of mines, &c.

The president reminded those gentlemen who had recently joined the institution, of the engagement they had entered into, to present original communications, or drawings, &c., and urged upon the members of all classes the necessity of furnishing good papers, so that the interest of the meetings might be sustained, and the usual discussions be promoted.

INSTITUTION OF MECHANICAL ENGINEERS.

October 23, 1850.

J. E. M'Connell, Esq., Vice-President, in the Chair.

"On the form of Railway Axles," by Mr. Thomas Thorneycroft of Wolverhampton.

Since the reading of the paper on the form of railway axles, the author has had his attention specially directed to some of those points which it was the object of the paper to introduce and support.

In that paper, as well as in others on the same subject, a parallel had been drawn between the railway axle and the girder, as being somewhat alike in principle. Admitting the correctness of this opinion, the question would arise, why is the principle upon which every girder is made departed from in the case of the axle? If it is pleaded that the close proximity of the prop and load, and these acting at the extreme ends of the axle, has justified this departure from the girder principle, then it might be expected that girders loaded under very similar circumstances would, in like manner, be reduced in the middle; but not so. As a case in point, reference might be made to the girders which suspended those parts of the Britannia tubes which pass through the towers, where the prop and load are at the extreme ends of the girder, and within a few inches of each other; yet these girders are parallel, although for a distance equal to the width of the tube there is no load whatever.

The principal reason which has been assigned for reducing axles in the middle is the supposition that, when parallel, the effect of the forces from lateral and vertical percussion tends to break the axle behind the wheel—that being the point where the greatest amount of fractures have taken place. The author is however of opinion, that the simple and only cause of the fracture of axles at that particular point is the shoulder, which it has been the practice to leave on the axle as a stop to the wheel. Some of the experiments now before the Institution, prove at least, that where a shoulder exists the strength of the axle is reduced more than one-half, which affords presumptive proof that there are other causes in constant operation (beside the arrestment of the wave of vibration), inducing fracture at that particular point.

It has now become the opinion of some engineers, that in every case of collision, or other derangements of a train when in motion, that axles reduced smaller in the middle are unable to keep their form, and that such axles exposed to violent lateral blows are easily sent beyond the limit of their elasticity; the consequence is, the wheels leave the rails, and contribute directly to greater damage than would ensue were the train to keep the line.

A short time ago, some disarrangement of a train took place on the Shrewsbury and Birmingham Railway, in which case three or four carriages were nearly broken to pieces; the axles of these carriages were all reduced in the middle, and nearly all of them were more or less bent, while some of the carriages in the same train with parallel axles suffered little or no damage, and there was not one parallel axle bent in the slightest degree. Such a result might have been anticipated, when it is remembered that the resistance which the middle of an axle offers to a bending force is as the cube of its diameter. Hence, if we take the diameter of the centre of a reduced axle at $2\frac{5}{8}$ inches, the cube of which is 18·08, and then take the diameter of a parallel axle of the same weight, which would be $3\frac{1}{4}$ inches, the cube of which is 34·32, we find that, with the same quantity of material, the parallel axle has the advantage of the reduced one, to resist all the forces to which axles are subject by 90 per cent. So early as 1842, the Mechanical Section of the British Association had the subject of the fracture of railway axles fully discussed, after a number of excellent remarks by Mr. Nasmyth on the different causes which tended to destroy the fibre of iron, and render it brittle. He observed, that simply nicking iron to the extent of only $\frac{1}{100}$th of the area took away $\frac{1}{10}$th of its strength. Mr. Fairbairn at the same time expressed his opinion, that the two chief causes of the breakage of railway axles were bending and percussion, these changed the fibrous to the crystalline structure. In a paper read by Mr. J. O. York before the Institution of Civil Engineers in 1843, reference was made to the fleeting bars used as levers for turning the large screws for forcing forward the shield in the Thames Tunnel, that they never lasted longer than three or four weeks, although very strong, and made from the best materials; and that, when fracture took place, they exhibited a bright crystallized appearance, clearly showing that oft-repeated bending without any concussion, had destroyed the fibre of the iron, and rendered it quite brittle.

A mass of evidence might be adduced to prove, that the internal structure of iron undergoes no change, unless there be a change of form; and that simple jarring or vibration will not destroy the fibre of iron, whereas bending, if long continued, will change the most fibrous iron into crystalline,—therefore the author would fully subscribe to the opinion of one of the railway commissioners, who has stated, "that it was of importance to avoid deflection on railway axles, as deflection was almost as fatal as fracture in causing accidents."

GLASGOW PHILOSOPHICAL SOCIETY.

"On Sanitary Reform, and the Use of Sewage Water of Towns." By James Smith, Esq., late of Deanston.

The author began by observing, that the causes of disease are to a great extent within our own power, and can be removed or diminished. There was much less sickness when the population was smaller and less crowded together; and it is found that the more populous a town becomes, the greater is the increase of endemic disease. Much of the disease in every country is caused by poverty and the want of domestic comfort, and, above all, by irregular habits. The latter cause is to be removed by moral means; the former, so far as it can be removed, by physical means. The most prominent cause of disease is the accumulation of the various putrifying matters generated by the community. He described the pernicious effects arising from defective sewage, and especially the decomposition of animal and vegetable matter in cess-pools. The removal of these substances, without allowing any portion of them to escape, would be the perfection of sewerage. This requires an unlimited supply of water, available at all times, under pressure in every apartment where matter is generated, to provide proper orifices for receiving it into air-tight sewers; such orifices to be thoroughly water-trapped, to prevent the possibility of the escape from the sewers of any smell or gas whatever into the apartment, which can be effectually done at small expense. The first thing to be done, therefore, in order to the removal of these noxious matters, is to provide an abundant supply of water. Then the question arose, are these decomposing substances useless, and to be thrown into the nearest river? or can they be made useful to the community by which they are generated? He proceeded to answer this question by showing how it could be applied to the purposes of agriculture, so that it could not only be got rid of altogether, but rendered, at the same time, a source of profit to the community. Various methods had been proposed for this purpose; some proposing that the matters of suspension should be allowed to deposit in ponds, to be afterwards dried, and used as a light portable manure, the watery part being allowed to flow into the rivers as heretofore; not adverting to the fact, that the watery part contains the greatest amount of enriching matter in solution. Others have proposed to precipitate the matter in solution, as far as it can be done, by cream of lime, or some such cheap agent, by which there would still be a sacrifice of the ammonia and alkaline constituents. Such treatment implies a considerable extent of space for the necessary apparatus, a considerable quantity of material for precipitation and desiccation, besides a great amount of expensive manipulation; whilst it has been ascertained that the application of the materials in their state of suspension and solution, as in the recent sewage water, is much more efficacious in promoting the growth of plants, than when extracted, dried, and otherwise prepared. But if it shall at any time be found that the manufacture of a portion of the manure in the dry state shall be desirable, manufactories can be established through the country on any of the main lines of pipe, apart from the town and the dense population. The removal of the sewage water in its original fluid condition by pumping, and its conveyance in pipes to the spot where it is to be applied, obviously afford a simple and efficient mode of dealing with it. It has been ascertained, by careful calculation, that sewage water can in this manner be taken up and conveyed a distance of ten miles, and be thrown upon the ground in most equal distribution, at a cost of 3d. per ton; containing all the elements, unchanged and undiminished, and be presented to the great chemist Nature, to be dealt with by the never-ceasing and costless labourers of the vegetable kingdom. The pumping, conveyance, and distribution had been tested at several places on a sufficient scale to demonstrate its perfect practicability and efficacy. The first experiment of the pumping, conveyance in pipes, and distribution by hose, was made at Clitheroe, in Lancashire, under Mr. Smith's direction, by Mr. Henry Thomson, of the extensive print-works there. The liquid consisted of the sewage of a village of the ordinary character, with that from the works, which contained, of course, a greater amount of soap suds and alkaline matter; this was thrown into a tank containing the drainage from a farm-yard. The pumping, conveyance, and distribution by the hose, answered admirably. The experiment was made on some old meadow land. This liquid was applied to a meadow at the rate of about eight tons per statute acre; whilst farm manure, at the rate of about fifteen per statute acre, was applied to a corresponding extent. The grass from the liquid manure grew considerably more luxuriant than that from the farm-yard manure; but, unfortunately, the relative weights produced were not ascertained on cutting. The next experiment was made on a farm on the estate of Possil, near Glasgow, by Mr. Robert Harvey, of the Port-Dundas Distillery, who, in the most enterprising and spirited manner, at Mr. Smith's suggestion, laid down pipes for conveying liquid manure over his whole farm, consisting of upwards of three hundred acres, and had the liquid manure from a dairy of upwards of five hundred cows pumped to an altitude of more than seventy feet. The distribution of liquid manure has been carried on on this farm for more than four years, very little solid manure being used except for comparative purposes. The distribution is chiefly on what may be termed the low-pressure system, as, instead of being jetted with force to form an artificial shower, it is simply allowed to be discharged upon the surface (by tin-plate pipes of about an inch and half in diameter, and four feet in length, fitting into each other with slip joints, and these can be led to discharge the liquid at any point within their range, which can be extended to a length of two or three hundred yards, if necessary). In this manner, one man can distribute the manure over from one to two acres per day. The manure is thus applied to pasture land, to grass for cutting, for house-feeding, and for making hay. It is applied also to stubble land, and to fallow; and has uniformly raised magnificent crops of grass, potatoes, turnips, wheat, beans, barley, and oats, on land not of the best quality. These men are employed during the whole year in distributing the manure, and go on in wet weather as well as in dry. Mr. Harvey has lately extended his system of pipes, and has erected a 12-horse engine, which is more than master of the work. The Sewage Manure Company of London, which obtained acts in 1846 and 1847, for taking a portion of the sewage water of Westminster, has, after much untoward obstruction and delay, got

to work with a 30-horse engine, and is now distributing the liquid in several of the market gardens at Fulham, and upon meadow land in the neighbourhood, with most satisfactory results. The Company receives £3. 10s. for the season's watering of the garden ground, and £2 for that of the meadow land. The results in growing lettuce have been very extraordinary, a market gardener admitting that he had sold the lettuce from an acre of land, so watered, fourteen days earlier than that from some land which had not been watered, and that the pecuniary result had been £25 per acre more. The operations of the Company are going forward, and in another season the value of liquid sewage manure will be fully demonstrated. The water at present applied by the London Company is very much diluted, and has very little smell, and being immediately absorbed by the ground, all offence is avoided. It was at first thought by the engineer of the Company that it would be necessary to employ their own servants to make the distribution; but it has been found in practice that the men, women, and boys who are usually employed about gardens are quite competent to the work under the direction of the master gardener, so that the whole matter is, in the meantime, left in his hands, to use the liquid as he thinks most fitting. It has been objected by some that the distribution of the sewage water would generate miasma all over the country, to which it may be replied that the matter taken from the sewers being in a fresh condition, and before it has had time to pass into any extensive decomposition, and being in itself much diluted with water to facilitate its conveyance and distribution, and being thrown over an extensive absorbing surface, with a great area of atmosphere, any poisonous matter that may emanate from it will be so diluted that it cannot affect the health of man or beast. It is impossible, with present information, to determine what may ultimately be the profit derivable to any community from this source; but taking what data we have from scientific inquiries, as well as that from the practical experience which has been worked out, it does not seem extravagant to anticipate a free yearly income of one pound for each individual of the community. But to render the estimate safe, in the first instance it may be made at ten shillings, which would afford to the city of Glasgow an income of at least a hundred and fifty thousand pounds, which would put it in the power of the public authorities to root out by degrees all the narrow and unwholesome lanes and the wretched dwellings, which are a disgrace to the present age, and to carry on continuously the progressive improvement of the city. It has been suggested by many that customers will not be found for the manure in this condition to so great an extent; but it must be obvious to every intelligent agriculturist who takes the trouble to make a survey of the surrounding country, and it will come home to the experience of every farmer, that there is everywhere a great want of manure to produce the fullest effect. If manure can be furnished in this manner at half the cost of ordinary manure, and be laid on the ground when the farmer wishes it, without carting over his land, with very little trouble to himself, and with results beyond the average of ordinary crops, there can be no doubt of finding customers everywhere. The crops of the farmer who uses this manure will excite the jealousy of his neighbours, which will lead them, I would almost say force them, to follow his example.

The question of the disposal of the sewage water in the liquid form, for agricultural purposes, being determined, the engineering of the system of sewers will be greatly simplified and rendered independent of tidal influence, as wells can be put down at points most convenient for the drainage of specific areas, and for the transmission of the liquid by the nearest route to the country. The sewerage should consist of a double system of air-tight tubular sewers, the one to receive the sewage water, the other to receive the rain water falling upon the streets and houses. All the inlets being securely trapped, so as to prevent the escape of any gas from the sewers, whatever gas may be generated must find its way to the general outlet, when it can be passed through the furnace of the pumping engine, and be thereby deprived of its noxious qualities, and be thrown into the air at a height above the streets and dwellings.

In order to test the usefulness of the manure in the liquid form, Mr. Smith said he had made extensive inquiries for several years. A number of experiments had also been made with the view of testing the practicability of dealing with it in the liquid form, and ascertaining the cost at which it could be pumped into pipes, and thus conveyed into the country. It was ascertained that sewage water can be conveyed, by pumping, ten miles, and delivered on the ground for 3d. a ton, with a moderate profit; whereas, to cart a ton for ten miles costs 5s. The liquid is not only conveyed at this charge, but distributed. The expense of distributing liquid manure by cart is considerable, and in the solid form it is more expensive still. Mr. Smith next remarked that the sewage water of large towns contains all the elements of the food used by the inhabitants and by animals. These elements exist in the state of mechanical mixture, of suspension, and of solution. A large dilution of these matters with water not only deprives them of smell, but fits them better for being applied to the land. The suspended matter moves easily in properly constructed sewers, and can be conveyed with facility through pipes. The sewage matter applied in the liquid form is much less liable to be washed away by rain, than when applied in the solid state; and besides, both chemical investigation and the results of experience combine to show, that solid manure is less valuable than manure in a state of suspension or solution. In the Meadows at Edinburgh, which are irrigated by sewage water, it is found that the matter in suspension has a tendency to lodge at the roots of the grass, causing decay; while the fluid manure which ultimately remains, after flowing through several meadows, produces the healthiest and best grass. Some of these meadows are let for £30 to £50 for the cutting of the grass. Six different specimens of water from the meadows, of a gallon each, yielded—

1. Water taken up immediately on its leaving the sewer, 244 grains of solid matter, and 82 grains in solution.

2. Taken as it flowed from subsidence pond, 52 grains of solid matter, and 87 grains in solution.

3. Taken after having flowed over one plat, 31 grains of solid matter, and 89 grains in solution.

4. Taken after having flowed over several plats, 15 grains of solid matter, and 82·7 grains in solution.

5. Taken still farther on, 2½ grains of solid matter, and 67·2 grains in solution.

6. Taken at the sea when passing away, 2½ grains of solid matter, and 72·9 grains in solution.

The meadows farthest from the source of the sewage water consist of poor sandy land, yet they produce better grass, in consequence of the water being deprived in its progress of its grosser matter held in suspension. Mr. Smith observed that sewage water contains a larger proportion and variety of nutritious matter than even guano.

Mr. Smith illustrated by diagrams the method of sewerage recommended by him, showing the importance of having a sufficient and uniform fall in the sewerage, and of using small air-tight pipes, instead of the large ones commonly employed.

ROYAL INSTITUTION, MANCHESTER.

October 16, 1850.

"On Voltaic Ignition and Illumination,"* by W. E. Staite, Esq.

Now we should not forget that this electricity is evolved as the direct result of the decomposition of the electrolyte; and that the metals, and other elements engaged, are concerned chiefly in producing and facilitating the requisite chemical action to effect such decomposition. In the case of acidulated water in voltaic arrangements, the acid, for instance, not only renders the electrolyte a better conductor, but serves at the same time to keep the surface of the positive metal clean and free from the oxide as it forms.

The evolution of electric power, then, in each and every such case, must be considered as due to chemical action; for, if the chemical action be stopped even for a single moment, the electric power ceases. Now, we can have no chemical action without motion. By motion we must understand atoms disturbed,—atoms in a state of vibration, transition, or undulation,—atoms not in a state of equilibrium or rest, being affected either attractively or repulsively by contiguous atoms. Motion, then, is as intimately connected with chemical affinity, as chemical affinity is with electricity. From the electricity of the pile, we further obtain magnetism, and also heat in any circuit where the free transmission of the power is impeded; impeded motion in every instance being attended by the development of heat, of which friction is another example. Again:

Bodies heated to 960 degrees Fahrenheit, radiate light, another agent; and light itself, when decomposed, is found to be a compound of three distinct rays, namely, the red, or heating ray; the yellow, or luminous ray; and the blue, or chemical ray, called the actinic;—each ray being capable of producing distinct physiological effects. The constitution of solar light becomes in this view a problem of the highest interest, seeing that, in the solar ray, we have light, heat, and chemical power united. The decomposition of light from voltaic ignition, gives results similar to those obtained from the sunbeam; and whatever may be the peculiar physical arrangement on which the development of solar light, heat, and actinism depend; by parity of reasoning, we may assume, that the secondary causes are similar in both instances, seeing that the resulting phenomena are identical.

With regard to the nervous power in man and animals, which we propose calling "Neuralism," and ranking it as a separate agent, we may observe, its phenomena can be simulated by electricity resulting from chemical action, to an extent which warrants the conclusion that they are allied powers. The bodies of animals recently dead, if brought under the influence of current electricity, exhibit many of the phenomena of life. Even the processes of respiration and digestion have been carried on for certain periods after life has ceased. We have no time to enlarge upon these facts; suffice it to say, that in certain animal organisms, these agencies are found to exist together, such as in the Torpedo and Gymnotus Electricus,—animals capable of giving severe shocks to the nervous system, by the exercise of what we will suppose to be neuralism, or concentrated nervous power. This nervous power we find to be identical with current electricity, for the phenomena are the same, and the spark even has been obtained from the gymnotus, when the animal has been greatly excited: showing, in all probability, that nervous power is capable of conversion into electric power, as the electric power is capable of conversion into neuralism.

Of the constitution of these agents, we are permitted to know a great deal, through the phenomena they exhibit but of their abstract nature we know nothing whatever. That they are not in themselves material, though intimately associated with matter, must be evident from a variety of considerations,—such, for instance, as the inconceivable speed at which they are transmitted,—their imponderability,—the subtle nature of their agency, and so on. No argument in favour of their materiality can be based upon the ground of their potency, but rather the reverse for we find in nature, those powers which are the most exalted in dignity and potency, are the least material in their nature. See the gradation, by way of example, in the following scale:—Earth, air, chemical affinity, electricity, heat, vegetable life, animal life, nervous power, human will, and, at the summit of all the impalpable Divine Omnipotence.

We shall now show experimentally, and as one example, how these agents, namely, motion, chemical affinity, electricity, magnetism, heat, and light, may be produced in one common line of conduction; motion, with chemical affinity in the

* Continued from page 189, for November.

voltaic pile, being, in this case, the initial power. [The experiment was as follows:—Motion and chemical affinity were illustrated in the battery; polarization of the wires and electricity were shown in the deflection of the magnetic needle; electro-magnetism in the helix or coil; heat in the intense ignition of wire and light, as exhibited in two small iridium lamps, placed in different parts of the circuit. This novel experiment was eminently successful, and was much applauded.]

Voltaic ignition cannot occur independent of exalted heat. Heat is supposed by many philosophers to be a force latent in all material substances, even where its presence cannot be detected by the most delicate instruments. For instance, there is said to be latent heat in ice, and in frozen mercury. The doctrine of latent light in bodies has also numbered amongst its advocates names entitled to our highest respect. To differ in opinion with men so distinguished and eminent, is an act of temerity we would willingly shrink from, did not a sense of truth, and love of the value of truth, urge us to a contrary course. That it is impossible, in our present state of knowledge, to define the limits wherein heat could be said to be present as heat, must be admitted; and also with regard to light, it may exist, attenuated, beyond the point our most perfect powers of vision can penetrate; yet, there must be limits in both cases. To speak of heat as latent in bodies, whose only characteristic is excessive frigidity, or of light as latent in substances remarkable only for excessive darkness, is to subvert the entire meaning of words, to do violence to common sense, and render our scientific nomenclature a contradictory and absurd mass of terms. Heat, moreover, is an expansive power. All bodies in which heat is present have a tendency to occupy more space than they occupied before; and as the nature of heat (whatever that may be) cannot change, heat cannot be present in any material substance without exercising its expansive agency. Heat must always be heat, and heat as an active agent, unless it be actual matter, cannot in any sense be held latent in bodies,—that is, hidden, stored, bound up, secreted amongst the ultimate atoms,—for if it were there at all as heat, its presence would be manifested through its dynamic effects. And as to light, if by the term light we are to understand that which appeals to the organs of vision, and can be comprehended by them, the hypothesis of latent light is an absurdity, for it involves this inevitable conclusion, that light may be darkness, and that darkness may be only light in a latent state.

MONTHLY NOTES.

Provisional Registration of Designs.—The following regulations as to the Provisional Registration Act, have just been issued from the Board of Trade:—

1. All persons desirous of effecting registration or provisional registration of any design, must furnish to the registrar (except in any case in which, under the 11th section of the Designs Act, 1850, he may dispense with any of such particulars) two copies, drawings, or prints of such design, and, if such design is intended for exhibition at any place certified by the lords of the said committee to be a place of public exhibition within the meaning of the Designs Act, 1850, then a third copy, drawing, or print also.

2 In the case of paper-hangings, calico prints, and other furnitures of such a nature as to admit of being conveniently pasted in a book, portions of such furnitures may, with the permission of the registrar, be received for the purpose of registration, instead of the copies, drawings, and prints before mentioned.

3. Upon the face of the sheet containing such copy, drawing, or print, or if a portion of the article to be registered be furnished to the registrar, as before provided, then, upon a sheet of paper attached thereto, or delivered therewith, must be set forth the name of every person claiming to be the proprietor of the design, or the style or title of the firm under which he trades, together with his place of abode, or place of carrying on his business, or other place of address; and also, in the cases after mentioned, the following further particulars (except where the registrar may dispense with any thereof as aforesaid); that is to say:

1. If the registration of such design be sought in respect of the application thereof to ornamenting any article of manufacture or substance, there must, if the registration sought be complete registration, be set forth the number of the class or classes described in section three of the Designs Acts, 1842, in respect of which the registration is made; or

2. If such design be for the shape or configuration of any article of manufacture having reference to some purpose of utility, the drawings or prints must be made on a proper geometric scale, and there must be set forth the title of the design, and such description thereof in writing, as may be necessary to render the same intelligible, and the description must distinguish such parts of the design (if any) as are not new or original, and every such drawing or print, together with the title or description of such design, and the name and address of the proprietor, must be on one sheet of paper or parchment, and on the same side thereof, and the size of such sheet must not exceed 24 inches by 15 inches, and there must be left on one of such sheets a blank space, on the same side on which are such drawing, title, description, name and address, of the size of six inches by four inches, for the certificate hereinafter mentioned.

4. All persons desirous of effecting registration of any sculpture, model, copy, or cast, within the protection of two several acts passed respectively in the 38th and 54th years of the reign of King George III., and intituled respectively "An Act for encouraging the art of making new Models and Casts of Busts and other things therein mentioned," and "An Act to amend and render more effectual an act for encouraging the art of making new models and casts of busts and other things therein mentioned," which two acts are, in the said Designs Act, 1850, called the "Sculpture Copyright Acts," must furnish to the registrar such copy, drawing, or print, or such description, writing, or print, as in the judgment of the registrar shall be sufficient to identify the particular sculpture, model, copy, or cast, in respect of which registration is desired, and the name of the person claiming to be the proprietor, together with his place of abode or business, or other place of address, or the name, style, or title, of the firm under which he trades.

5. The registrar shall affix a number upon every such copy, drawing, print, or description of any design, sculpture, model, copy or cast, so to be furnished to him as aforesaid, denoting the order in which the same has been received by him, and a corresponding number upon the duplicate and triplicate copy, drawing, print, or description, directed to be furnished to him as aforesaid: and he shall register every such copy, drawing, print, or description, in the order in which it is received by him, by entering the number thereof, and also the title or class thereof, in a book to be kept by him for that purpose; and he shall keep a proper index of all the designs, sculptures, models, and copies or casts so registered, according to the titles thereof, or arranged in such classes as to afford ready access to the same.

6. Whenever any such registration is made, the registrar shall retain and file in his office one of the copies, drawings, prints, or descriptions hereinbefore required to be furnished to him, and he shall return the other thereof, (when two only are furnished) to the person by whom the same was furnished, having first affixed thereon or attached thereto a certificate, whereby he shall certify, under his hand and seal of office, the fact of such registration, and the date, and the name of the registered proprietor, or the style or title of the firm under which he trades, together with his place of abode or business, or other place of address: and he shall cause the remaining copy, drawing, print, or description (when three have been furnished), having the certificate of provisional registration affixed thereon, to be deposited in the place of public exhibition so to be certified as aforesaid.

7. Persons desirous of having the transfer of any registered design registered, must furnish to the Registrar the written transfer of such design, or other sufficient evidence of their title, together with a written request to register, to the effect set forth in the 6th section of the Designs Act 1842, and the registrar shall thereupon insert the name of the new proprietor in the register. If a certificate of the transfer be desired, the certified copy of the design, or an exact copy thereof, must be furnished to the registrar for the purpose of having such certificate affixed thereon; and the registrar shall accordingly affix thereon a certificate under his hand and seal of office, containing the like particulars as are herein required in the case of a certificate of the registration of a design.

8. Any person desirous of ascertaining whether, with respect to any particular design, there be any copyright existing, must produce to the registrar such design, together with the registration mark thereof; or he may produce such registration mark only; or in the case of a design provisionally registered, the number thereof; and thereupon the registrar shall give to such person a certificate under his hand and seal of office, stating whether there be any copyright of such design existing, and if there be, then in respect to what particular article of manufacture or substance such a copyright exists, and the term of such copyright, and the number and date of the registration thereof, and also the name and place of abode or business, or other address of the registered proprietor thereof.

9. All the services hereinbefore directed to be performed by the registrar are to be performed on payment of such fees as may be from time to time fixed by the Lords Commissioners of her Majesty's Treasury.

Exhibition of 1851.—We have received the following letter from the Secretary of the Executive Committee:—"Several applications having been made to the Executive Committee to permit the names of intending exhibitors to be copied, and many similar applications made to local committees having been referred to the Executive Committee for their opinion, the Executive Committee have directed me to say that they have no authority to permit such lists to be taken. They also apprehend that no such authority exists in the local committees to give any lists of the exhibitors without the permission of the exhibitors themselves. I am also instructed to add, that it has come to the knowledge of the Executive Committee that the publication of names before the Exhibition opens is contrary to the wishes of many exhibitors. Under these circumstances, the Executive Committee are of opinion that it would be most consistent with the wishes of exhibitors themselves, and with the duties of the local committee, that no list of its intending exhibitors should be given by them without the authority of each individual exhibitor having been first obtained."

Certificates of Competency under the New Mercantile Marine Act.—The Lords of the Committee of Privy Council of Trade having given notice that they had determined to grant certificates of competency under the above-named act to all masters and mates who had obtained certificates, under the regulations for establishing examinations issued by their Lordships on the 19th of August, 1845, in all cases in which there are no special reasons to the contrary, the number of certificates sent in to the Registrar-General of Seamen at the Custom-house to be exchanged for certificates of competency (since the 15th inst., the first day of issuing them), has exceeded 3000. Examinations for certificates of competency will henceforth be conducted under the superintendence of the local marine boards at the several ports under-mentioned, with the exception of London, which will be made direct to that board recently appointed. In transmitting their present certificates masters and mates must name the port at which they wish to receive them. By this new regulation no master, first, second, or only mate will be able to act in that capacity in any foreign-going ship after the 31st of December next unless he possesses a certificate either of competency or service under the Mercantile Marine Act. The following are the ports at which local boards have already been established for the purpose of granting certificates:—England—London, Liverpool, Bristol, Hull, Newcastle, Plymouth, Shields, and Sunderland; Scotland—Aberdeen, Dundee, Glasgow, Greenock, and Leith; Ireland—Belfast, Cork, and Dublin. Several other ports are expected to be appointed for the issuing of certificates, after the act has been some time in operation, for the convenience of our merchant service.

BECKERS' SELF-ACTING RAILWAY SIDING STOP.—An ingenious little contrivance has recently been registered by Mr. G. E. Beckers of Paddington, and applied for the purpose of a stop to prevent carriages from getting out of their sidings on to the main line. The rail is slightly recessed to allow the lever arm or stop-piece to come down when a carriage enters the siding, the arm being fast on a short horizontal shaft, having a counter weight on its opposite end. The carriage wheel depresses the stop as it enters, but immediately that it has passed, the counter weight again elevates it, and as it is incapable of a reverse action, it acts as a firm check to the return of the wheel, until depressed by hand for that purpose.

ENGLISH PATENTS.

Sealed from 24th October, to 21st November, 1850.

Jean Louis Pascal, Moorgate-street, London, civil engineer,—"An improved apparatus for the cure and prevention of smoky chimneys, and also for the ventilation of ships, rooms, and buildings in general."—24th October.

Thomas Beale Browne, Hampen, near Andoversford, Gloucester, gentleman,—"Improvements in weaving and preparing fibrous materials, and staining or printing fabrics."—(Communication.)—24th.

Alexander Dixon, Abercorn Foundry, Paisley,—"Improvements in moulding iron and other metals."—24th.

John Mercer, Oakenshaw, within Clayton-le-Moors, Lancashire, gentleman,—"Improvements in the preparation of cotton, and other fabrics and fibrous materials."—24th.

John Oliver York, Boulogne-sur-Mer, France,—"Improvements in the mode or manner of generating steam in locomotive, marine, and other boilers."—24th.

John Grant, Hyde Park-street, Middlesex,—"Improvements in heating and regulating temperature."—24th.

Aaron Rose, Halesowen, Worcester, manufacturer,—"A certain new or improved method, or certain new or improved methods, of manufacturing twisted gun and pistol barrels."—24th.

Samuel Jacobs, Highgate, Kendal, Westmoreland, cabinet maker,—"Certain improvements in printing on woollen, cotton, paper, and other substances, parts of which improvements are applicable also to the purposes of colouring, shading, tinting, or varnishing such substances."—24th.

Bryan Millington, Brant-Broughton, Lincoln, of the firm of Millington & Sons, Newark-upon-Trent, Nottingham, millers,—"Improvements in corn-cleaning and flour-dressing machines."—24th.

Edward Clarence Shepard, Parliament-street, Westminster, gentleman,—"Certain improvements in electro-magnetic apparatus suitable for the production of motive power, of heat, and of light."—(Communication.)—24th.

Matthew Hodgkinson, Red-street, near Newcastle-under-Lyne, Stafford, mine-agent,—"Improvements in furnaces or apparatus for smelting ores or minerals, and for the making of pig-iron."—2d November.

Victor Emile Warmont, Neuilly, Seine, France,—"Improvements in dycing wool and other fibrous materials and fabrics."—2d.

Joseph Christian Davidson, Yalding, Kent, brickmaker,—"Improvements in lime and other kilns and furnaces."—2d.

John Matthews, Kidderminster, foreman,—"Improvements in sizing paper."—2d.

Jonas Bateman, Upper-street, Islington, cooper,—"Improvements in life-boats."—2d.

Archibald Slate, Woodside Iron Works, Dudley,—"Improvements in canal navigation."—2d.

Pierre Antoine Auguste de la Barre de Nanteuil, Leicester-street, Middlesex,—"Improvements in propelling carriages."—(Communication.)—2d.

William and Colin Mather, Salford, engineers, and Ferdinand Haselowsky, Berlin, Prussia, engineer,—"Improvements in machinery for washing, steaming, drying, and finishing cotton, linen, and woollen fabrics."—2d.

John Borland, Norfolk-street, Strand, engineer,—"Certain improvements in weaving machinery."—2d.

John Slate, Wandsworth, Surrey, accountant,—"Improvements in stoves and furnaces, and in chimney-pots and regulators."—2d.

John Tatham and David Cheetham, Rochdale, Lancaster, machine-makers,—"Certain improvements in the manufacture of cotton and other fibrous materials, and fabrics composed of such materials."—2d.

Richard Clyburn, engineer to the firm of D. Maclean & Son, St. George-street East, Middlesex,—"Improvements in wheel carriages."—(Partly a communication.)—2d.

James Black, Edinburgh, machine-maker,—"A machine for folding."—(Partly a communication.)—7th.

Richard Archibald Brooman, of the firm of J. C. Robertson & Co., Fleet-street, patent agents,—"Improvements in railways."—(Communication.)—7th.

William Fairbairn, Manchester, Lancaster, civil engineer,—"Improvements in cranes and other lifting or hoisting machines."—7th.

William Crane Wilkins, Long-acre, Middlesex, engineer,—"An invention for lighting, and in apparatus for lighthouses, signal, floating, and harbour lights."—7th.

Samuel Edwards, James Ansell, and Patrick Heyns, Shadwell, Middlesex, engineers,—"Certain improvements in obtaining and applying motive power, and in pumps."—7th.

George Frederick Morrell, Fleet-street, London, gentleman,—"Improvements in obtaining and applying motive power, and also in pumps."—7th.

John Alexander Lorew, Boston, America, gentleman,—"Certain improvements in sewing machines."—7th.

Benjamin Guy Babington, George-street, Hanover-square, Middlesex, Doctor of Medicine,—"Improvements in preventing incrustation of steam and other boilers."—7th.

Robert Clare, jun., Exchange-buildings, Liverpool, gentleman,—"Improvements in the manufacture of metallic casks."—7th.

John Robinson, Stepney, Middlesex, engineer,—"Improvements in lifting and moving fluids and other bodies, and in apparatus for steering ships and other vessels."—7th.

David Christie, St. John's-place, Broughton, Salford, Lancaster, merchant,—"Improvements in machinery or apparatus for preparing, carding, spinning, doubling, twisting, weaving, and knitting cotton, wool, and other fibrous substances, also for sewing and packing."—(Communication.)—7th.

Robert Lucas, Furnival's-inn, London, mechanical draughtsman,—"Improvements in telegraphic and printing apparatus."—(Communication.)—7th.

Thomas Main, Strand, Printer,—"Improvements in printing machinery."—8th.

James Rock, jun., Hastings, Sussex, coach-builder,—"Certain improvements in carriages, which are also applicable, in whole or in part, to other machinery."—9th.

William Palmer, Sutton Street, Clerkenwell, manufacturer,—"Improvements in the manufacture of candles and night lights."—9th.

James Scott, Falkirk, N. B., shipwright,—"Certain improvements in docks, slips, and apparatus connected therewith."—9th.

Sir Francis Charles Knowles, Lovell, Bucks, Bart.,—"Improvements in the manufacture of charcoal."—9th.

Lucien Vidie, 14 Rue du Grand Chantier, Paris, France, French advocate,—"Improvements in measuring the pressure of air, steam, gas, and liquids."—9th.

Joseph Nye, Mill Pond Wharf, Kent-road, engineer,—"Improvements in hydraulic machinery, parts of which improvements are applicable to steam engines and machinery for driving piles."—12th.

George Robins Booth, London, engineer,—"Improvements in the manufacture of gas."—12th.

Peter Spence, Pendleton, Manchester, manufacturing chemist,—"Improvements in the manufacture of alum and certain alkaline salts, and in the manufacture of cement, part of which improvements are applicable in obtaining volatile liquids."—12th.

Edwin Clark, Palace New-road, Middlesex, civil engineer, and Henry Mapple, Child's Hill, Hampstead,—"Improvements in electric telegraphs, and in apparatus connected therewith."—12th.

Henry Medhurst, engineer, in the employ of Messrs. Shears and Sons, Bankside, Southwark,—"Improvements in gas meters."—12th.

Etienne Masson, Place St. Michel, Paris, gardener,—"Improvements in the preparation of certain vegetable alimentary substances for the provisioning of ships and armies, and other purposes where the said substances are required to be preserved."—12th.

John Ball, Ashford, Kent, engineer,—"Improvements in applying heat to bakers' ovens and their appendages."—12th.

Henry Wimshurst, Limehouse, Middlesex, shipbuilder,—"Improvements in steam engines, in propelling, and in the construction of ships and vessels."—12th.

Charles Marsden, Kingsland-road, Middlesex, engineer,—"Improvements in scissors and thimbles."—12th.

William Duckworth, Liverpool, coffee merchant,—"Certain improvements in the manufacture of chicory, with certain improvements in the machinery or apparatus for the manufacture thereof."—14th.

Thomas Shore, Exwich, Devon, miller,—"An improved method of dressing flour."—14th.

Robert Howarth, 61 Chapman-street, Oldham-Road, Manchester,—"Improvements in machinery for raising a nap on cotton, woollen, silk, and other fabrics."—14th.

Abraham Haley, Frome, Somerset, machinist,—"Certain improvements in looms for weaving."—14th.

Edward David Ashe, Brompton, Middlesex, Lieutenant in Her Majesty's Navy,—"A new or improved nautical instrument or instruments applicable especially amongst other purposes to those of great circle sailing."—14th.

John Swindells, of the firm of Swindells and Williams, Manchester, and Juce, near Wigan, manufacturing chemist,—"Certain improvements in obtaining products from ores and other matters containing metals, and in the preparation and application of several such products, for the purpose of bleaching, printing, dyeing, and colour making."—14th.

Joseph Conrad Baron Liebhaber, Paris, France,—"Improvements in blasting rocks; also in working marble and stone, and in preparing products therefrom."—14th.

Charles Allemand, Paris, France, gentleman,—"An improved apparatus for producing light."—14th.

Thomas Coats, Ferguslie, Paisley, Renfrew, Scotland, thread manufacturer,—"Certain improvements in turning, cutting, and shaping wood and other materials."—16th.

Joseph Martin, Liverpool, Lancaster, rice miller,—"Improvements in machinery and apparatus for cleansing and otherwise treating rice and certain other grains, seeds, and farinaceous substances."—16th.

Thomas Allan, St. Andrew's-square, Edinburgh, printer and publisher of the *Caledonian Mercury*,—"Certain improvements in electric telegraphs, and in the application of electric currents for deflecting magnets and producing electro-magnets."—16th.

William Laird, Liverpool, Lancaster, merchant, and Edward Alfred Cooper, Handsworth, Warwick, engineer,—"Improvements in machinery for loading and discharging certain descriptions of cargo in ships and other vessels, and in the construction of such vessels."—16th.

John Hosking, Islington, Middlesex, engineer,—"Certain improvements in valves applicable to pumps, and also in apparatus to regulate the pressure and flow of water, air, and through pipes."—19th.

Thomas Dunn, Windsor Bridge Iron Works, Pendleton, near Manchester, Lancaster, engineer,—"Improvements in machinery and apparatus for moving engines from one line of rails to another, and for turning them; also for compressing certain substances, and for raising and lowering heavy bodies."—19th.

Paul de Tolstoy, Paris, France, General in the service of His Majesty the Emperor of Russia,—"Improvements in dredging machines."—(Being a communication.)—19th.

Clement Augustus Kurtz, Manchester, Lancaster, practical chemist,—"Improvements in dyeing."—(Being a communication.)—19th.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—"An improved composition, applicable to the coating of wood, metals, plaster, and other substances which are required to be preserved from decay, which composition may be also employed as a pigment or paint."—(Being a communication.)—19th.

Robert Brown, Liverpool, Lancaster, plumber and brassfounder,—"Improvements in the application of pumps for raising and forcing water."—19th.

Henry William Ripley, Bradford, York, dyer,—"Improvements in dressing and finishing piece goods."—19th.

John James Greenough, Strand, Middlesex, gentleman,—"Improvements in the construction of chairs, couches, and seats, parts of which improvements are also applicable to various purposes where springs for supporting heavy bodies and resisting sudden and continuous pressure are required."—(Being a communication.)—21st.

SCOTCH PATENTS.

Sealed from 22d October, to 22d November, 1850.

Etienne Masson, Place St. Michel, Paris, gardener to the Central Society of Horticulture of France,—"Improvements in the preparation of certain vegetable alimentary substances, for the provisioning of ships and armies, and other purposes where the said substances are required."—25th October.

Zecariah Morley, Regent's Park, Middlesex, Esq.,—"Certain improvements in the means or methods of, or apparatus or machinery for, decomposing water, and applying the products to useful purposes."—(Communication.)—28th.

Robert Lucas, Furnival's Inn, Middlesex, mechanical draughtsman,—"Improvements in telegraphic and printing apparatus."—(Communication.)—31st.

George Michiels, London, gentleman,—"Improvements in treating coal, and in the manufacture of gas, and also in apparatus for burning gas."—5th November.

William Henry Ritchie, Kensington, Surrey, gentleman,—"Improvements in Stoves."—6th.

Peter Spence, Pendleton, Manchester, manufacturing chemist,—"Improvements in the manufacture of alum and certain alkaline salts, and in the manufacture of cement, parts of which improvements are applicable in obtaining volatile liquids."—7th.

Alfred George Anderson, Great Suffolk-street, Surrey, soap manufacturer,—"Improvements in the treatment of a substance produced in soap-making, and its application to useful purposes."—7th.

John M'Nicoll, Liverpool, Lancaster, engineer,—"Improvements in machinery for raising and conveying weights."—7th.

John Lienau, jun., Wharf-road, City-road, Middlesex, merchant,—"Improvements in purifying or filtering oils and other liquids."—7th.

John Tatham, and David Cheetham, Rochdale, Lancaster, machine-makers,—"Certain improvements in the manufacture of cotton, and other fibrous materials, and fabrics composed of such materials."—7th.

Hugh Mair, Ingram-street, Glasgow, North Britain, manufacturer,—"Improvements in certain classes of figured muslins, and in the machinery or apparatus employed in the manufacture or production thereof which improvements, or parts, are applicable to harness weaving generally."—11th.

George Hurwood, Ipswich, county of Ipswich, engineer,—"Improvements in grinding corn, and other substances."—11th.

Rodolphe Helbronner, Regent-street, Middlesex,—"Improvements in preventing the external air, and dust and noise, from entering apartments."—11th.

Evan Protheroe, Austin Friars, London, merchant,—"Improvements in the manufacture of oxide of zinc, and in making paint from oxide of zinc."—11th.

James Samuel, Willoughby House, Middlesex, civil engineer,—"Certain improvements in the construction of railways and steam-engines, and in steam-engine machinery."—12th.

Theodore Cartali, Manchester, Lancaster, merchant,—"Certain improvements in the treatment or preparation of yarns or threads, for weaving, and in the manufacture of certain woven fabrics."—(Communication.)—13th.

John Clare, jun., Exchange-buildings, Liverpool, gentleman,—"Improvements in the manufacture of metallic casks."—13th.

Charles Bury, Salford, Lancaster, manager,—"Certain improvements in machinery or apparatus for preparing and spinning, doubling or twisting silk waste, cotton, wool, flax, or other fibrous substances."—13th.

Richard Clyburn, engineer to the firm of D. Maclean and Son, St. George-street East, Middlesex,—"Improvements in wheel carriages."—(Communication.)—14th.

John Tucker, Royal Dockyard, Woolwich, Kent, shipwright,—"Improvements in steam boilers, and in gearing, cleansing, and propelling vessels."—(Communication.)—15th.

John Robert Johnson, Crawford-house, Middlesex, chemist,—"Improvements in fixing colours on fabrics made of cotton or other fibre."—15th.

Clement Augustus Kurtz, Manchester, Lancaster, practical chemist,—"Improvements in dyeing."—15th.

Antoine Pauwels, Paris, France, merchant, and Vincent Dubochet, Paris, France, merchant,—"Certain improvements in the production of coke, and of gas for illumination, and also in the regulating the circulation of such gas."—18th.

Robert Cotgrave, Eccleston, Chester, farmer,—"Certain improvements in machinery or apparatus for draining and cultivating land."—19th.

John Hamilton, Prince's Square, Glasgow, and John Weems, Johnstone, Scotland,—"Improvements in warming and ventilating buildings and structures."—20th.

John Turner, Birmingham, Warwickshire, engineer, and Joseph Hardwick, same place, builder,—"Certain improvements in the construction and setting of steam boilers."—28th.

Alexander Mein, accountant, Glasgow, trustee upon the sequestrated estate of the late James Smith of Deanston, North Britain,—"Certain improvements in treating the fleeces of sheep when on the animals."—20th.

William and Colin Mather, Salford, engineers, and Ferdinand Kaselousky, Berlin, in the Kingdom of Prussia, engineer,—"Improvements in machinery for washing, steaming, drying, and finishing cotton, linen, and woollen fabrics."—21st.

Edwin Pettit, Birmingham, Warwickshire, civil engineer,—"Improvements in the manufacture of glass, and in the method of forming or shaping and ornamenting vessels and articles of glass, and in the construction of furnaces and annealing kilns."—22d.

John Mathews, Kidderminster, foreman,—"Improvements in sizing paper."—22d.

William Radley, chemical engineer, and Frederick Meyer, oil merchant, both of Lambeth, Surrey,—"Improvements in treating fatty, oleaginous, resinous, bituminous, and cerous bodies, the manufacture and application of them, and of their compounds and subsidiary products, together with the apparatus to be employed therein, to new and other useful purposes."—22d.

IRISH PATENTS.

Sealed from 30th October, to 13th November, 1850.

Maxwell Miller, Glasgow, Lanarkshire, coppersmith,—"Improvements in distilling and rectifying."—October 30th.

Charles Bury, Salford, Lancashire, manager,—"Certain improvements in machinery or apparatus for cleaning, spinning, doubling, and throwing raw silk."—November 4th.

Antoine Pauwels, Paris, France, merchant, and Vincent Dubochet, Paris, France,—"Certain improvements in the production of coke, and of gas for illumination, and also for regulating the circulation of such gas."—11th.

William Parker, Sutton-street, Clerkenwell, manufacturer,—"Improvements in the manufacture of candles and wicks."—11th.

Robert Lucas, Furnival's Inn, London, mechanical draughtsman,—"Improvements in telegraphic printing apparatus."—11th.

Etienne Joseph Hanon Valcke, of the kingdom of Belgium, miller,—"Improvements in grinding."—13th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 15th October, to 19th November, 1850.

Oct. 15th.	No. 2483.	George Rolfe, and William Stacey, Bradford,—"Perforated ventilating valve cover."
16th,	2484.	John Nurse, Crawford-street, Bryanstone-square,—"The cabriolet or curricle Brougham, with self-acting step-piece."
—	2485.	John Raphael Isaac, Castle-street, Liverpool,—"Cork or stopper."
17th,	2486.	Gustavus Ed. Beckers, Railway Station, Paddington,—"Self-acting siding stop."
18th,	2487.	Cook and Williams, Prince's-street, Hanover-square,—"Respirator stock or tie."
—	2488.	Cook and Williams, Prince's-street, Hanover-square,—"Face and chest protector."
—	2489.	Susan Walker, The Grove, Hersham, Surrey,—"A patinette."
21st,	2490.	William Towns, B.A., St. John's College, Cambridge,—"Spirit meter."
22d,	2491.	John Scholl, Berwick-street, Oxford-street,—"Smoke consumer for gas-burners."
23d,	2492.	George Moseley, John's-place, Grange-road,—"Safety pin."
24th,	2493.	F. B. Geither, Birmingham,—"Expanding dining-table."
—	2494.	William Poupard, Wych-street, Strand,—"Curvilinear beam for weighing-machines."
25th,	2495.	E. O. Tindall and L. Tindall, Scarborough, York,—"Tindall's smoke-elevator."
—	2496.	Key, Mitchell, and Friez, Newgate-street,—"Convertible bedstead."
—	2497.	Edward Greaves, Sheffield, brass founder,—"Variable pendulum, or portable metronome."
29th,	2498.	Bryan, Donkin and Co., Grange-road, Bermondsey,—"Rotary rag-boiler for paper-makers."
—	2499.	Walter F. Robinson, Lieut. R.N., Junior United Service Club,—"Self-acting safety plug, or stopper for boats and other vessels."
—	2500.	Robert Watts, Manchester,—"Metallic packing for pistons."
29th,	2501.	Joseph Harvey, Westminster Bridge-road,—"The Richmond car."
29th,	2502.	Charles Maschwitz, Jun., Birmingham,—"Box or case for postage stamps."
—	2503.	Dushoit and J. Roaf, Finsbury Pavement,—"The bush tent."
—	2504.	Thomas Parker, Kensington,—"Knife and fork cleaner."
30th,	2505.	Charles Rowley, Newhall-street, Birmingham,—"The Prince's vest button."
—	2506.	John Smith and Henry Wills Ditchett, of the firm of Smith and Co., St. Augustine's-parade, Bristol,—"Blind roller."
31st,	2507.	Swaine and Adeney, Piccadilly, whip manufacturers,—"Universal whip socket."
—	2508.	C., A., and T. Ferguson, Mast House, Millwall, Poplar,—"Gun carriage to facilitate the training and working of heavy guns."
—	2509.	Chapman and Son, Frith-street, Soho-square,—"Moveable button."
—	2510.	Lauric and Marner, Oxford-street, carriage-builders,—"Invisible carriage step."
—	2511.	Earl, Smith, and Co., Sheffield,—"The triple file."
Nov. 1st,	2512.	William Laschallas, Budge-row,—"Pentagon envelope."
—	2513.	Isaac Naylor, Burton, near Barnsley,—"Alarm gun."
—	2514.	John Fernihough and Sons, Victoria Works, Dukinfield,—"Double furnace smoke-burning horizontal tube steam boiler."
2d,	2515.	William Curtis Hugman, Great Ormond-street, Queen-square,—"Portable folding truss."
4th,	2516.	George Percy Tye, Birmingham,—"Hyacinth glass and support."
—	2517.	David Duthoit and Job Roof, Finsbury Pavement,—"The ærial tent."
5th,	2518.	Thomas Lambert and Son, Short-street, New-cut, Lambeth,—"Economic fountain lamp."
—	2519.	Robert and John Garrard, Loman-street, Gravel-lane, Southwark,—"Nautical glazed felt hat."
—	2520.	William Edward Jenkins, George-street, Euston-square,—"Embossing machine for stamping with ink, paper and other material."
6th,	2521.	Edouard Auguste Jaillard, Bedford-street, Strand,—"Travelling case."
—	2522.	Browning and Rigby, Adelphi Iron Works, Salford, engineers,—"Compound cylinder steam engines."
7th,	2523.	John Verrinder, Lincoln,—"Box table and sofa-bedstead."
—	2524.	Jenkins and Ashford, Birmingham,—"Mattress."
—	2525.	James Tonkin, Oxford-street,—"Improved spring lath."
—	2526.	William Wilson, King-street, Manchester,—"Hot-water cistern for baths," &c.
8th,	2527.	Thomas Moore Sharp, Belfast,—"Improved paddle-wheel."
—	2528.	George Horton, Thomas-street, Manchester,—"Joiners' brace."
9th,	2529.	George Broughall, Willenhall, Stafford, key stamper,—"Improved steam stamp."
11th,	2530.	C. and J. Clark, Street, near Glastonbury, Somerset,—"Parts of shoes."
12th,	2531.	Fowler and Fry, Temple-gate Factory, Bristol,—"Improved cart."
13th,	2532.	Martin Billing, Newhall-street, Birmingham,—"A lithographic perforating and registering machine."
14th,	2533.	Frederic Grosjean, Regent-street,—"Der Fuszwärmer (a railway rug or wrapper)."
—	2534.	Thomas Foxall Griffiths, Birmingham,—"Saucepan lid."
—	2535.	Lord Brothers, Canal Street Works, Todmorden, York,—"Improved hook for the weight hooks of lap and other machines."
15th,	2536.	Thomas Foxall Griffiths, Birmingham,—"Candlestick."
—	2537.	Lorant Poirier, Bucklersbury,—"Improved lithographic press, for printing circulars and other small forms."
—	2538.	Jenkins and Wolmershausen, Curzon-street, Mayfair,—"Lady's riding habit."
18th,	2539.	Waddington and Son, Coleman-street,—"Etui bis-utile, or parasol and knitting case."
19th,	2540.	Thomas Rutter, Harborne,—"Nail."
—	2541.	Arthur Jerningham, Portsmouth, Commander in the Royal Navy,—"Letter clip."
—	2542.	John Martindale and Thomas Bowman, Globe-road, Mile-end,—"Poche-au-chapeau."

TO READERS AND CORRESPONDENTS.

Constant Reader, Bury.—The manufacture of gun-cotton has been repeatedly described, and as most schoolboys have achieved a reputation for its production, we should have thought that any one who has the luck to be a "constant reader" of ours, would have been well up to the details of the process. Ordinary cotton is immersed in a mixture of concentrated sulphuric and nitric acids, in equal parts, for about three minutes. The cotton is afterwards washed in pure water and dried.

A Working Mechanic.—Receipts of this class are scattered in tolerable profusion through the periodical and encyclopædic works of the last few years. For the particular ones he mentions, see "Ure's Dictionary of Arts," &c., and "Greener on Guns," both of which are to be found in the library of most Mechanics' Institutions.

D. V., Greenshields.—We shall probably be able to avail ourselves of his sketches next month.

A Reader, Manchester.—The action of the second draw needs no explanation, at least to parties acquainted with the same movement in ordinary mules. If he looks into this, we think he will at once see the arrangement, and save us from a labour of redundancy in detailing it.

J. G. O., Sheffield.—It is matter of frequent regret to ourselves, that neither our time, nor the space afforded us by the pages of the *Practical Mechanic's Journal*, will permit us to produce treatises on specific subjects, for the benefit of individual readers. If he looks into "Smeaton on Mills," and "D'Aubuisson's Treatise on Hydraulics," he will learn more on the subject than we can possibly instil into him through the limited medium at our command.

W. B. Manchester.—Nicholson's Work is an excellent one. See also "Pugin's Gothic Architecture." We ought to know his exact position as a student before recommending any particular guide.

J. B.—We shall engrave his pressure regulator for next month.

Artificial Light.—p. 85, for July.—Dele "decomposed carbon," and read "aqueous vapour and carbonic acid."

Humphry's Pump-Valve.—For "three-fourth valve," read "three-feather valve."

J. P., Manchester.—We shall be glad to hear from him at his convenience.

W. B. J.—We have not been able to find room this month.

A Correspondent writes,—"I am at a loss to decide upon a curious point which has come before my notice during the last few days. I find that metallic surfaces which have been exposed to heat, such as parts of steam-engines, after standing some time, present an appearance of perspiration. I should be glad to find some elucidation of this curious phenomenon.—W. S. *Nov.*, 1850."

Apalachicola, U.S.—We are compelled to postpone this to next month.

MACLARDY'S COTTON MACHINERY.

Fig. 1

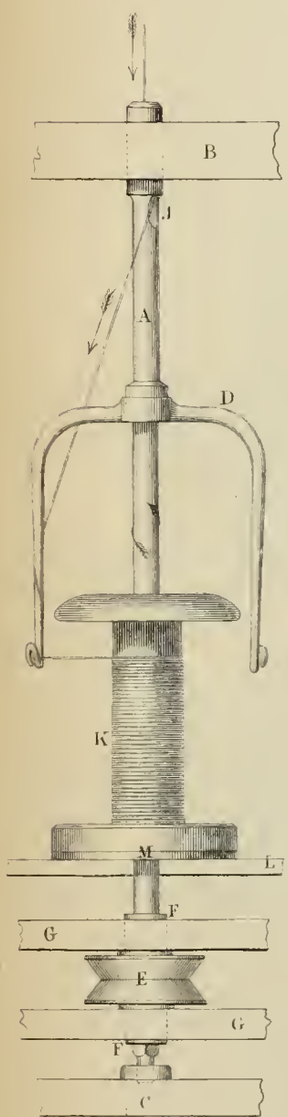


Fig. 2

Fig. 3

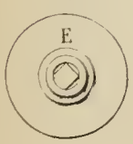


Fig. 4

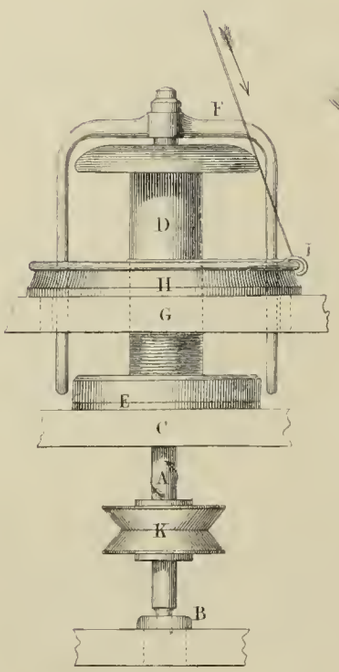


Fig. 5

Fig. 6

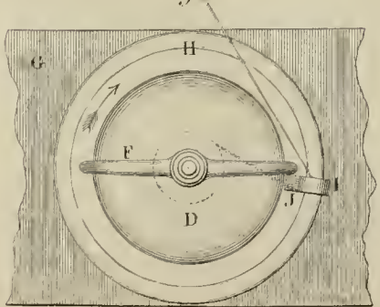


Fig. 7

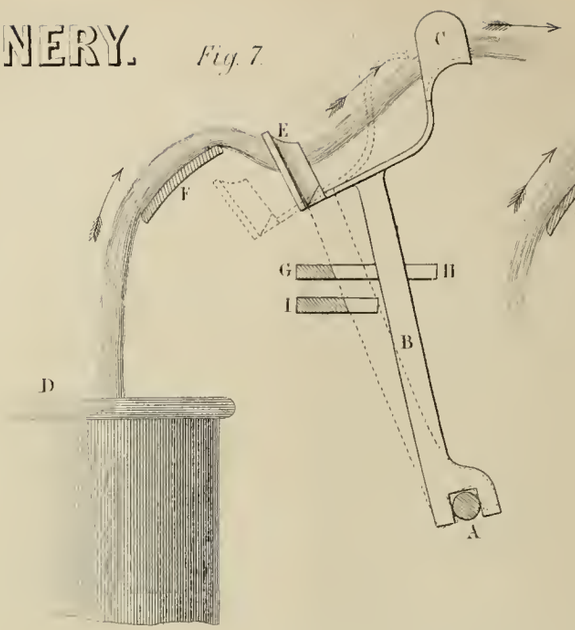


Fig. 9.

Fig. 11.

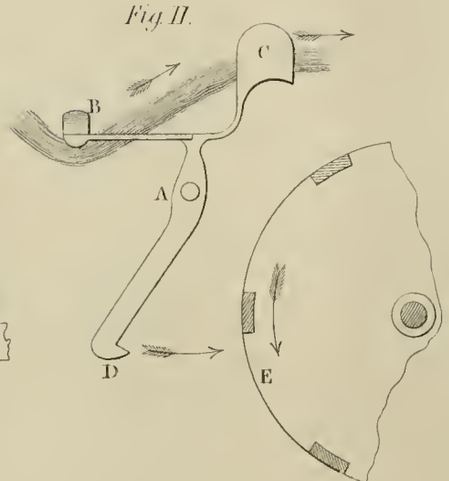


Fig. 8.

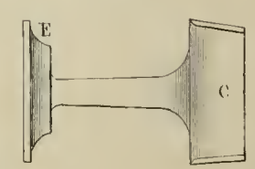


Fig. 10.

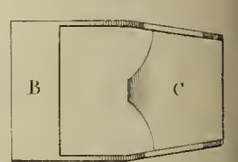
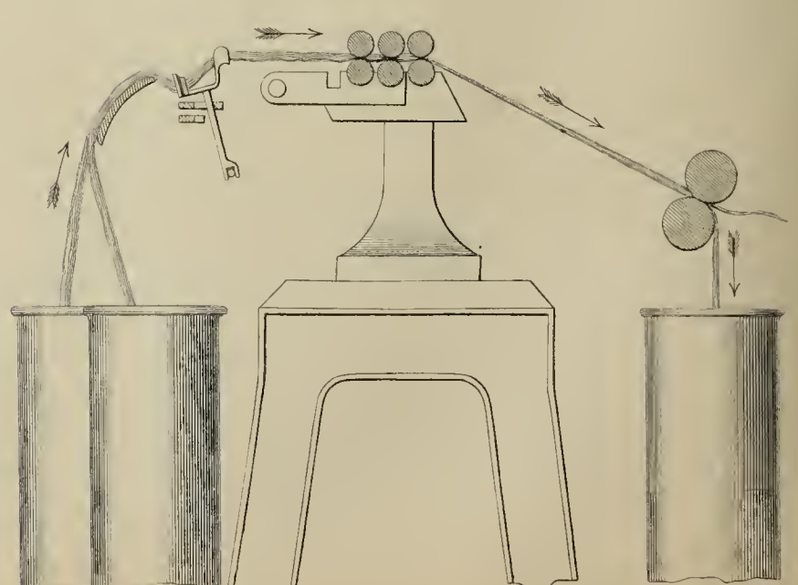


Fig. 12.



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MACLARDY'S IMPROVED COTTON MACHINERY.

INDEPENDENT WARVE BEARINGS—COMBINED FLYER AND "RING AND TRAVELLER"—DUPLEX CONDUCTOR FOR DRAWING-FRAMES.

(*Illustrated by Plate* 63.)

The improvements in that vast range of mechanism devoted to textile processes, which we this month present to the readers of the *Practical Mechanic's Journal*, are the result of the active practical avocations of Mr. William Maclardy of Barton Bridge, Manchester. The particular points to which he has, in this instance, given his attention, are briefly distinguished at the head of the present paper, and may be more specifically described as follows:—

1. The removal of the objectionable vibration and lateral strain ordinarily arising from the side tension of the driving bands of spindles, by setting the driving warves in separate and independent bearings, so that whilst the spindle is driven as certainly and accurately as before, it is in no way acted upon by any deranging action of the warve.

2. The combination, in throstle-frames, of the common flyer with the "Niagara" or "ring and traveller" movement, whereby the known advantages of the latter are retained, in conjunction with the regular and uniform driving action of the flyer.

3. An arrangement for increasing the certainty of action of the "stop motion" of drawing-frames, by the use of a "duplex spoon," or conductor, to give a greater frictional action to the passing sliver, and allow the lever arm of the spoon to work at a greater angle, involving less delicacy in the original setting of the spoon.

The whole of these ingenious modifications are fully delineated in Plate 63, to which we must now refer the reader for a detailed explanation of the several movements.

Fig. 1. represents a complete elevation of a throstle spindle, flyer, bobbin, and driving warve, as mounted for working, but detached from the spinning frame. Fig. 2 is a vertical sectional elevation of the driving warve of the spindle, detached; and fig. 3 is a corresponding plan of the same. In this arrangement, the spindle, A, revolving in a top-bearing rail, B, and supported in a foot-step, C, is furnished with a flyer, D, of the ordinary form, but is driven or caused to revolve by a warve, E, mounted in independent bearings of its own, instead of being fast upon and carried round with the spindle, without any supporting bearings, as in fig. 4. The warve, E, is cast or formed with two projecting collars or bushes, F F, one on each side, such collars being turned true with the warve itself, to form accurate bearings to revolve in the two bolster rails, G G, which are suitably bored for the purpose, and extend along the entire length of the frame, one above and one below the line of warves.

In this way the warve is fitted to revolve in its two bearings perfectly independent of the spindle. The vertical section, fig. 2, of the warve, and the plan of the same, fig. 3, represent the peculiar formation of the two bearings and the bore for the spindle. When the warve is cast, a square core is laid in its axial line, and it is then bored out, so that the lower half of the length of the hole shall be square, as at H, in the section, fig. 2, to fit to a corresponding short square formed on the lower end of the spindle, immediately above the part which enters the footstep, C. The upper half is of a regular cylindrical bore, to fit to the portion of the cylindrical spindle immediately above the square, as at I, in fig. 2. In this way, the lower part of the spindle, which fits accurately but easily to the warve, when passed through the latter, turns with it, as if the two were fastened together in the usual manner, whilst the spindle having a free vertical movement, may be easily raised out of its position in the warve, for the purposes of doffing and cleaning. The warve is driven by a band in the usual manner, but as it is entirely supported by its two collar bearings, perfectly independent of the spindle, all lateral strain arising from the tension of the driving band is borne by the journals or bearings of the warve alone, so that the accurate revolution of the spindle upon its own fixed centre is not at all interfered with, and the objectionable vibration and side wear, ordinarily arising from the pressure of the band upon the spindle, are entirely obviated. The top of the spindle forming the bearing in the upper rail, B, is tubular, and the fly, D, is made fast upon the spindle sufficiently low to admit of the latter being lifted up, until its lower end is free of the warve. During the spinning operation, the thread enters the tubular top of the spindle, and passes out at the side aperture, J, thence round the leg of the flyer, and through the eye of the latter to the bobbin, K, the course being represented by the arrows. The bobbin is loose on the spindle, and is supported on the bobbin or copping rail, L, as usual, the yarn being taken up or wound upon the bobbin by the weight of the bobbin and the action of the friction washer, M, technically known as the "drag." The "doffing" is effected by raising the spindle vertically in its top and bottom bearings, until its lower end is free from the warve, when the lower end, being angled, or passed to one side of the working centre line, the bobbin is removed by slipping it off at the lower end. The top bearing of the spindle, being larger in diameter than the part below, which is parallel down to the square for the warve, the elevation of the spindle bringing the part, A, into the wider bearing, allows of this angling of the spindle, the copping rail being notched or cut out in front of the spindle, to allow the latter to pass through it towards the front of the frame, so that the doffing may take place when the copping rail is not at the bottom of its lift.

The improvement in the "ring and traveller" action is to be described in reference to figs. 4, 5, and 6. Fig. 4 is an elevation of a throstle spindle, flyer, "ring and traveller" bobbin, and warve, as mounted for working. Fig. 5 is a vertical section of the "ring" and copping rail, with the modified "traveller" upon it; and fig. 6 is a corresponding plan of the whole. The spindle, A, is mounted in the usual manner, being carried in a footstep, B, and an upper bearing in the bolster or bobbin rail, C; but the blade, or portion of the spindle on which the bobbin, D, works, is only about half the ordinary length. The bolster-bearing rail, E, is stationary, and the bobbin rests on a friction washer, E, laid upon the rail. The flyer, F, is screwed upon the spindle in the usual way, but has plain straight arms, without the curls ordinarily provided for the guiding of the thread. The copping rail, G, carries a ring, H, fitted with a traveller, I, the ring being made of much greater diameter than usual, in order that the flyer may revolve clear of the ring when the latter traverses vertically. The "traveller" is fitted to move freely on the edge of the ring in the usual way, but has a projection, J, formed upon its inner edge, so as to point towards the centre of the spindle. As the flyer revolves freely within the ring, one of its arms coming in contact with this projection, the "traveller" is carried round the ring at the same rate as the flyer.

The thread, as represented by the arrows, passes downwards as it leaves the rollers, round one of the flyer arms, and thence through the loop of the "traveller," in the usual way, to the bobbin. The bobbin is loose on the spindle, and takes up the yarn as it is spun, in the usual way, by means of the "drag." The copping rail, G, traverses vertically up and down, carrying with it the "ring and traveller," to lay on the yarn equally from end to end, whilst the bobbin has no vertical movement, as is usual in the common throstle, and the bobbin is thus filled without traversing at all on the spindle blade. The result of this arrangement is, that the spindle has a shorter length above the bolster-bearing, C, so that it may be worked at a higher velocity than is usual, whilst its lateral vibration is diminished.

As the "ring and traveller" traverses alternately up and down during the spinning action, the projection, J, of the "traveller" slides up and down in contact with the flyer leg, both of which are made straight throughout their vertical length, to produce an even action upon the "traveller." In this arrangement, the doffing action is effected in the

usual way, the flyer being screwed off the top of the spindle to release the bobbin.

The improvements in preparing cotton and other fibrous materials, consist of a novel and peculiar form of spoon or conductor, adapted to what is ordinarily known as the "stop-motion" of drawing-frames, for suspending the action of the machine when any of the slivers break in passing from the can or receiver to the back rollers. The object of this apparatus, which is termed "a duplex spoon," is to give the stop-motion a greater certainty of action, without involving so much delicacy in the origiual setting of the spoon as is usual in the common stop-action. Fig. 7 represents a side elevation of one form of "duplex spoon" for drawing-frames; and fig. 8 is a plan of the same corresponding. The spoon rests, as in the common arrangement, upon the fixed bar, A, as a centre, such bar running along the side of the frame to carry the necessary range of spoons. The short lever, B, has formed upon its upper end the usual guide-spoon or mouth, C, through which the sliver passes in the direction of the arrows from the can, D, at the back, to the back roller; but, in addition to this guide, a second conductor is formed at E, of the tubular or trumpet kind. The sliver plate, F, over which the sliver passes in entering the spoons, is, in the new arrangement, elevated sufficiently high to cause the sliver to bear against the upper side of the trumpet mouth, E, whilst it afterwards passes over and acts upon the conductor, C, in the usual way.

In this way a duplex frictioual action is produced upon the sliver and spoon surfaces, so that the spoon may be held up out of contact with its stopping mechanism, at a greater angle than is usual with the common single spoon, and hence it has so much more certainty of falling and stopping the frame when the sliver breaks and ceases to act upon the conductor. The conductor is mounted in the ordinary way, being supported on the bar, A, whilst it is guided in the slotted guide-plate, G H. The full lines in fig. 7, represent the conductor as it stands when the drawing-frame is in action, the sliver being in the act of passing through in its unbroken complete state. Should the sliver give way, its tension being removed from the conductor, the latter will be no longer held in this position, towards the front end, H, of the slot, but will fall backwards to the opposite end, G, as represented by the dotted lines. In this position the back of the lever, B, falls against the front edge of the longitudinal traversing plate, I, which has a series of notches or recesses formed in it, one recess for each conductor.

This plate being constantly traversed back and forward along and immediately behind the line of conductors, works clear of the latter when held up by the slivers, hut when any one falls, its lever enters its corresponding notch in the traversing plate, I. The plate is thus held by the conductor, and this stop has the effect of disengaging the machine from the driving power, as is well understood by practical men. As the double friction produced by this "duplex spoon" has a much greater effect than the single action of the common spoon, in enabling the sliver to hold up the spoon free of the traversing plate, it is obvious that the spoon need not be so delicately balanced, as the greater inclination at which it works, permits it more readily and certainly to come into contact with the stop apparatus when the sliver does give way. It is also, for this reason, less liable to accidental derangement. Fig. 9 represents a similar elevation of another modification of a "duplex spoon" or conductor; and fig. 10 is a corresponding plan. This conductor acts in a manner precisely similar to that already described, but the duplex action is secured by a slightly different form of parts, the sliver being passed from its plate, A, beneath the projecting angular arm, B, and thence over the second spoon, C. In this arrangement the second frictional action is obtained from the upward pressure of the sliver against the lower side of the arm, B, acting as the additional conductor.

The same form of "duplex spoon" is represented in fig. 11, as adapted to a balanced lever-conductor, carried on pivots at A. The sliver passes beneath the angular arm, B, and thence over the guide, C, as before. When the sliver gives way, the upper part of the spoon being heavier than the lower lever end, falls back, and the catch, D, on the latter end, advancing forward in the direction of the arrow, enters one of the bars or detents of the constant revolver, E, as is well understood by parties conversant with this class of machinery.

Fig. 12 represents the "duplex spoon" as fitted to a drawing-frame, the frame being shown in transverse sectional elevation.

To the practical cotton-spinner, it will be unnecessary to enlarge upon the successful removal of acknowledged defects which Mr. Maclardy's inventions have accomplished.

THE LYELLIAN THEORY OF GEOLOGICAL PHENOMENA.

The theory of Sir Charles Lyell, as to the uniformity of the causes which brought about the present conformation of the earth's surface and interior, and those which are now in daily operation, though but coldly received at first, has of late made much progress amongst geologists. Whatever conclusion we may come to as to the theory itself, or as to the evidence adduced in its support, there can be but one opinion as to the mode in which its author has placed it before the world. The clearness with which he states his views, the patience he displays in collecting and investigating facts, the wide range of his illustrations, the logical closeness of his reasonings, and the candour of his manner, are qualities that render his works, what Mrs. Somerville has styled them, "models of philosophical investigation."

In the hope that an outline of the theory may not be unacceptable to our readers, we have drawn up the present paper, in which we shall allow the author to speak for himself as much as possible. It may be stated generally in the following propositions:—

The forces now operating upon and beneath the earth's surface are the same, both in kind and degree, with those which, at remote epochs, have worked out geological revolutions. The ancient and present fluctuations of the organic and inorganic world, belong to one continuous series of events, governed by uniform laws, similar to those now in operation, and were never brought about by sudden, violent, and general catastrophes.

In support of these views, Sir Charles has examined, with great care, the action of existing causes of change in the animate and inanimate world; and he has brought together a great mass of facts, which, though they may fall short of proving the theory in question, at least prove this —that many more of the changes anciently produced in the solid exterior of the globe, are to be attributed to causes still in hourly operation than has hitherto been imagined.

It is urged that this theory supposes the lapse of such enormous quantities of time, that it may fairly be said to assume there never was a beginning to the present order of things; but he replies, that an astronomer might with equal justice he accused of asserting that the works of creation extend through *infinite* space, because he refuses to take for granted that the remotest stars now seen in the heavens are on the utmost verge of the material universe. All that Lyell would say is, that the geological monuments hitherto submitted to our inspection, whilst nowhere offering decided evidence of a commencement, require that we should allot to their formation an incalculable amount of time—an amount which seems, in fact, to increase the more closely we examine the phenomena, so that, instead of our approaching the signs of a beginning, they seem to fly from us. It may be argued, that as it is generally admitted that the creation of man took place at a modern epoch, what difficulty is there in conceiving the first creation of the planet itself? A reply is ready: there would he no difficulty at all in such a conception, did the facts permit us to form it. Our conviction that the present system of change has not gone on from all eternity, may he strengthened by the argument above stated; but that argument affords no warrant for presuming that we shall be permitted to behold the signs of the earth's origin, or the evidence of the first introduction of organic beings. "We aspire in vain to assign limits to the works of creation in *space*, whether we examine the starry heavens, or that world of minute animalcules which is revealed to us by the microscope. We are prepared, therefore, to find that in *time* also the confines of the universe lie beyond the reach of mortal ken."

Since the deposition of the older sedimentary strata, the earth's surface has experienced great changes of climate. There is evidence to show that the mean annual temperature of the northern hemisphere was considerably more elevated when the carboniferous and more ancient strata were deposited, than it is at present; that the climate has been modified more than once since those epochs, and that it has been reduced

by successive changes more and more nearly to that now prevailing in the same latitudes.

The evidence supporting the first proposition is afforded by the fossil remains of the oldest or eocene tertiary deposits. Shells of the genus nautilus, and other forms characteristic of tropical latitudes,—fossil reptiles, such as the crocodile, turtle, and tortoise,—plants, such as palms and cocoa-nuts, are found in these deposits; whilst, in the miocene and pliocene formations, the organic remains indicate climates successively less warm. If we proceed further back, and examine the rocks from the new red sandstone to the chalk, inclusive, we find many distinct assemblages of fossils, all of unknown species, and many of them referable to genera and families now most abundant between the tropics. Coral reefs, large chambered shells, and the associated plants, also lead us to infer an elevated temperature. The strongest evidence, however, is supplied in proof of the existence of an extremely uniform, moist, warm, and equable climate, in those latitudes which are now the colder and the most variable regions of the globe, by the more ancient coal deposits. The discovery of the bones of mammoths, and other large mammalia inhabiting a cold climate, is not to be held as conflicting with this theory. These bones are only found in the deposits of sand, gravel, and loam, which took place at the close of the tertiary period, and when undoubtedly a less genial climate was intercalated between the previous warm condition of the globe and that we now enjoy. At this epoch some revolution in the meteorological state of the earth occurred, and an aretic fauna invaded the temperate latitudes both of North America and Europe. Lyell then adduces reasons for supposing that these vicissitudes in climate may be reconciled with the existing order of nature, seeing that such order, in the lapse of ages, produces considerable variations in the relative position of land and sea, and that changes of no less importance may be expected to occur in future times. He shows that there are grounds for inferring that the eras of the principal alterations of climate, as deduced from fossil remains, were coincident with the periods of the most remarkable changes in the former position and relative proportions of land and sea. Sir John Herschel here comes to the geologist's assistance, by proving that the *mean* amount of solar radiation is dependent on the eccentricity of the earth's orbit, and therefore liable to variation.* Now, it is known that the eccentricity of the orbit is actually diminishing, and has been so for ages beyond the records of history. The ellipse is consequently becoming more and more circular, and the actual average of solar heat radiated to the earth is on the *decrease*. Whether the amount of decrease in the eccentricity is sufficient to account for any sensible refrigeration, remains still to be considered.

Lyell next considers the theory of progressive development, or the notion that the order of precedence in the creation of animals, considered chronologically, has precisely coincided with the order in which they would be ranked according to perfection or complexity of structure —a theory which has been put forward by Sir H. Davy and others as inconsistent with the doctrine, that the present order of things is the ancient and constant order of nature, only modified by existing laws. This theory Lyell regards as resting upon a very insecure foundation. For, first, as to *plants*—the carboniferous rocks are the earliest from which safe conclusions can be drawn, and in them the vegetable remains are not confined to the simplest forms, but belong, on the contrary, to all the leading divisions of the vegetable kingdom. Again, as to *animals*—vertebrated animals are found in the most ancient of those strata, of which it can be said that we possess extensive information as regards their fossils, namely, in the old red sandstone, and even in some silurian or primary fossiliferous limestones below it. In the oldest strata of the tertiary group, we find the remains of a great assemblage of the highest or mammiferous order, all of extinct species. In the later strata of the same group, other forms of species, distinct from those preceding and those following, are found; but in this succession no signs of a progressive development of organization can be detected.

Many persons entertain the belief, that the intensity, both of aqueous and igneous forces in remote ages, far surpassed that which we witness in our own times; but he thinks that such belief is unsupported by fact. He discusses Elic de Beaumont's theory respecting the origin of mountain chains, viz., that various independent ranges have been suddenly thrown up at particular periods, and that all contemporaneous ranges are parallel to each other. We think he succeeds in showing that all the facts adduced by de Beaumont may be true, and yet that they do not warrant the conclusion which he has drawn from them. Moreover, facts have come to light since the promulgation of the theory, which cannot be reconciled with the reasoning used to support it. Neither can he regard the more compact stony and crystalline texture of the older, as compared with the newer rocks, as any argument in favour of the dissimilarity of the causes operating at remote and recent eras. The differences of texture may be fairly attributed to various solidifying causes, such as the pressure of superincumbent matter, subterranean heat, &c., which influences, we may suppose, are as active as ever in modifying the aspect and internal structure of stratified deposits.

In a chapter of elaborate argument, he examines whether the series of past changes in the animate and inanimate world have not proceeded in a uniform manner. It has been generally thought that the analogy was slight in kind, and still more slight in degree, between the causes which produced the former revolutions of the globe, and those now in every-day operation. And certainly, when the fossiliferous formations are arranged in chronological order, the series of monuments is seen to be broken and defective; horizontal systems of strata abruptly succeed those that are highly inclined; rocks of distinct mineral composition are placed in juxtaposition; strata containing well-distinguished fossil remains are in contact. To account for these manifest violations of continuity, it has been usual to consider that the past history of the planet was made up of alternate periods of tranquillity and convulsion. But instead of believing that nature has been prodigal of violence, and parsimonious of time, Lyell endeavours to show that a regular and uninterrupted series of changes may give rise to such breaks in the sequence, and such unconformability in position, as the crust of the earth discloses.

And, first, as to the course of fluctuation in the animate world. It is true that the sedimentary strata are divisible into a variety of groups, distinguishable by dissimilarities in their organic remains; and there can be no doubt that man is a creature of quite recent introduction. We have at least one unequivocal instance of extinction of an organic being, viz. the dodo, and although we are not cognizant of a single instance of the first appearance of a new species, we cannot therefore assume that the successive introduction of new species may not be a constant part of the economy of the terrestrial system, as it appears to have been hitherto. He asserts that though many chasms are met with in passing from the older to the newer members of the tertiary system, yet there are no broad lines of demarcation between one state of the organic world and another. There is nothing to indicate an abrupt termination of one fauna and flora, and the coming into existence of new and wholly distinct forms. On the contrary, the assemblage of fossil species discovered in strata of the eocene period (species which are wholly different from those now living), is only reached in passing through strata of more recent periods by many successive steps; and exhibiting, it may be, a perfectly connected transition from the recent to an extinct fauna, but yet so related that there are no signs of a crisis when one class of organic beings disappeared, and another suddenly took its place. It may well be, therefore, that the extinction and creation of species have been and are the result of a slow and gradual change in the organic world.

When the same question is considered with reference to subterranean movements, proofs are adduced that there are spaces on the globe several thousand miles in circumference, which have been for a long period, and are at this moment, slowly and gradually subsiding without any occurrence of a sudden movement. Other large areas on the globe's surface are undergoing an insensible movement upwards. Now, an examination of the strata of every age demonstrates that the subterranean movements by which such strata have been affected, have not always been in the same direction. There is evidence of great oscillations of large level tracts having been elevated, then depressed, then again elevated. The conformability of some strata, and the unconformability of others, afford an inference that the subterranean forces were not acting upon every part of the globe at the same time, nor confined in their operation to one spot through all past time, but it may be inferred that they visited different parts of the globe at successive periods. Hence the fact of the alternate development and suspension of subterranean movements for indefinite periods within *limited geographical areas*, may be safely admitted by those who entertain the theory of the perpetual uniformity of the force by which such movements are effected.

Thirdly, to consider uniformity of change with reference to sedimentary deposition. It will probably be admitted, that at every former period there existed areas covered with water, and areas elevated above the water; in other words, that there were spaces which were the recipients, and others which were not the recipients of sedimentary matter; and consequently, that whilst a slow change of species was in simultaneous operation *everywhere* throughout the habitable parts of the land and sea, the fossilization of plants and animals was confined to those areas where new strata were produced. But these areas, as we have seen, were always shifting their position, so that the fossilizing process, by means

* The theorem is thus stated—"The eccentricity of the orbit varying the total quantity of heat received by the earth from the sun in one revolution, is inversely proportional to the minor axis of the orbit. The major axis is invariable, and therefore, of course, the absolute length of the year: hence it follows, that the mean annual average heat will also be in the same inverse ratio of the minor axis."

of which the commemoration of the particular state of the organic world at any given time is effected, may be said to move about, visiting and revisiting different tracts in succession. The shifting of these areas from one region to another is the next point to be considered. This shifting may be effected independently of subterranean force; for instance, by the accumulation of the sediment of rivers, and of marine sandbanks, both of which are causes of fluctuation. When, from any cause whatever, sedimentary deposition has been suspended over a given tract, and after a long lapse of ages renewed, the probability is, that the mineral character of the two deposits will vary considerably; and if we assume that species of animal existence were continually extinguished and introduced, it will follow that the fossils of strata formed at two distant periods on the same spot will also differ. It is then shown that a series of strata, bearing testimony to a gradual passage from one state of organic life to another, could only have been produced by a very rare combination of circumstances; the following conditions being requisite to the production of such strata—1st, a never-failing supply of sediment in the same region throughout a period of vast duration; 2d, the fitness of the deposit in every part for the permanent preservation of imbedded fossils; and 3d, a gradual subsidence to prevent the sea or lake from being filled up and converted into land. And yet it is precisely because the evidence of such gradation is not encountered at every step, that so many geologists embrace the doctrine of great and sudden revolutions in the history of the animate world.* It is probable indeed, that with the progress of geological investigation some of the great violations of continuity now existing in the chronological table of fossiliferous rocks will be removed or lessened; but we can scarcely hope ever to compile a consecutive history, by gathering together monuments which were originally detached and scattered over the globe.

The remainder of Mr. Lyell's treatise is devoted to an investigation of the changes now going on in the crust of the earth and its inhabitants. It is a patient and marshalled collection of facts respecting causes in daily action. He endeavours to estimate the aggregate result of ordinary operations multiplied by time, and by this course of proceeding he hopes to discover a key to the interpretation of the mysteries of the past.

The changes in question are brought about by two sets of causes, aqueous and igneous—antagonist forces, but both instruments of decay as well as of reproduction. Whilst aqueous agents are employed in reducing prominences, igneous agents are employed in producing inequalities. The latter he regards as the agents of a conservative principle (destructive as they appear to be), essential above all others to the stability of the system, because they are constantly repairing the waste of the surface effected by aqueous agents.

Aqueous Agents.—Vapour condensing upon the summit of mountains, carries along with it, in its progress to the sea, various salts and matter, mechanically suspended, which assist the simple force of the current in breaking down the obstacles it may meet with. Its expansion, when frozen, having penetrated as a liquid into small crevices, tears open the hardest rocks. Streams of small size easily transport coarse sand and gravel along slight declivities, and, when swollen, stones of considerable size. There are many instances of the enormous force put forth by water accidentally accumulated into a flood, which has suddenly broken its barriers. Ice is another form in which water exerts a power of transportation—river ice, glaciers, and bergs.

Many springs become highly impregnated with earthy and metallic matter in the interior of the earth, which is again deposited upon exposure to the atmosphere in the shape of tufa, travertin (calcareous), sinter (siliceous). Other springs contain large quantities of petroleum, pitch, &c.

The reproductive effects of rivers are seen in the deltas which they form in lakes, and around their mouths in the ocean. In the lake of Geneva, the land at the upper end has encroached seven miles within the historical period, and the deposits are gradually filling up the basin. The Rhone, after clearing itself in that lake, afterwards receives fresh contributions of earthy matter from the Arve and other streams, so that, when it enters the Mediterranean, it discolours that sea for six or seven miles. The delta of the Nile has a depth of 100 geographical miles—Memphis to the sea—and its base is more than 200 miles long. The area of the delta of the Ganges is much more than double that of the Nile, and discolouring matter brought down by the river extends sixty miles into the sea.† It is thought that the Brahmapootra pours an equal bulk of solid matter into the sea at the same point.

The operations of the great bodies of sea water, though extending over larger areas, are more concealed from our view than those of rivers. Their ceaseless motions, variously produced, are seen, however, to be slowly wearing away the shores in some places, and laying down new lines of coast in others, so that a gradual change in the form and position of the land is being produced at every point. Lofty cliffs are undermined by the action of waves, tides, and currents—hard rocks are hollowed, broken down, and removed. The materials thus obtained are carried to some place where the ocean is less habitually agitated, or to some depression in its bed, and in this way shoals and banks are formed. The bed of the German Ocean is traversed by several enormous banks—one of which, the Dogger Bank, is 354 miles long, the shallowest parts being only 42 feet below the surface.

Igneous Agents.—Under this head the volcano is first considered, then the earthquake, and lastly, the rising or sinking of land in districts where there are no volcanoes or earthquakes. He sketches, with minuteness, the geographical boundaries of volcanic regions; and draws attention to the fact, that although the points of eruption are but thinly scattered, constituting mere spots on the surface of vast districts, yet the subterranean movements extend simultaneously over immense areas. Active volcanic vents are usually arranged in lines, and between the points of eruption there is no doubt that subterranean fire is always at work, for the ground is from time to time convulsed with earthquakes, and there is other evidence of igneous agency. After detailing the effects of various earthquakes (seen within a brief period by the present generation), in the elevation or depression of enormous tracts, the protrusion of rocks, the destruction of towns, &c., he asks if it be possible to declare that the earth has at length settled into a state of repose, or to assert that changes in the relative level of land and sea, so common in former ages of the world, have now ceased? Evidence is then adduced to show that the land in Sweden is slowly rising, that of Greenland sinking; and he asserts, that whatever conjectures we may indulge in as to the cause of these movements, we cannot doubt that at some unknown depth beneath Sweden and the Baltic, the structure of the globe is becoming changed from day to day, throughout a space probably more than a thousand miles in length, and several hundred in breadth.

After commenting upon the facts which lead us to suppose that volcanoes and earthquakes spring from a common cause, the passage of heat from the interior of the earth to the surface, he proceeds to inquire whence that heat is derived. He rejects the hypothesis, that the central parts of the globe were created in a state of igneous fusion, and that the heat of the interior, though gradually diminishing, is still sufficient to keep a portion in that state. He believes that the heat is owing to chemical changes constantly going on in the earth's crust. We know that chemical combination is attended with the evolution of heat and electricity, which become in their turn the causes of fresh chemical changes; and further, that in the shell of the earth currents of electricity are continually passing.

Turning next to a consideration of the changes now in progress in the organic world, he first discusses Lamarck's theory of the tendency to progressive development, and St. Hilaire's opinion that there has been an uninterrupted succession in the animal kingdom, effected by means of generation, from the earliest ages of the world to the present day, and that the ancient animals, whose remains have been preserved, may have been the ancestors of those now in being. On the contrary, he thinks the facts prove that species have a real existence in nature, and that each was endowed, at the time of its creation, with the attributes and organization by which it is now distinguished. In other words, he believes that all the individuals propagated from one stock, have certain distinguishing characters in common, which will never vary, and which have remained the same since the creation of each species, although there is a capacity in all species to accommodate themselves, to a certain extent, to a change of external circumstances, a capacity of being modified, within certain limits, in form, colour, &c. If we embrace these opinions, we must suppose that a fresh effort of creative power was put forth whenever a new species made its appearance; and we may perhaps assent to the hypothesis, that each species had its origin in a single pair or individual, where an individual was sufficient, and that species were created in succession, at such times and in such places as to

* Professor Sedgwick is one of these geologists. In a lecture recently delivered by him at Kendal, he is reported to have said, with reference to the dynamical powers which in former ages were at work in elevating the bed of the ocean into huge mountains, and in producing those shattered and dislocated strata which are so conspicuous in rocks of older formations, that he does not believe the disturbing causes then in operation were uniform and similar in intensity with those which are still in action. "Facts prove that these phenomena were paroxyomal; and if a greater amount of disturbance is found amongst the more ancient strata (which certainly is the case), then an agent of proportionately greater power must have been at work to produce such effects."

† Mrs. Somerville states that the Ganges brings down 700,000 cubic feet of mud every hour, the Yellow River in China 2,000,000, and the Mississippi still more. It has been computed that it would take 1000 years to raise the bed of the ocean one foot by means of the sediment of all the rivers of the globe spread evenly over it; so that a deposit equal in thickness to that of the fossiliferous strata (7½ miles), would require nearly four millions of years, and it would take nearly four times as long to cover the whole surface of the globe to the same depth.

STEAM PUMP.

W. E. Garrett, Engineer; Leeds.

Fig. 1.

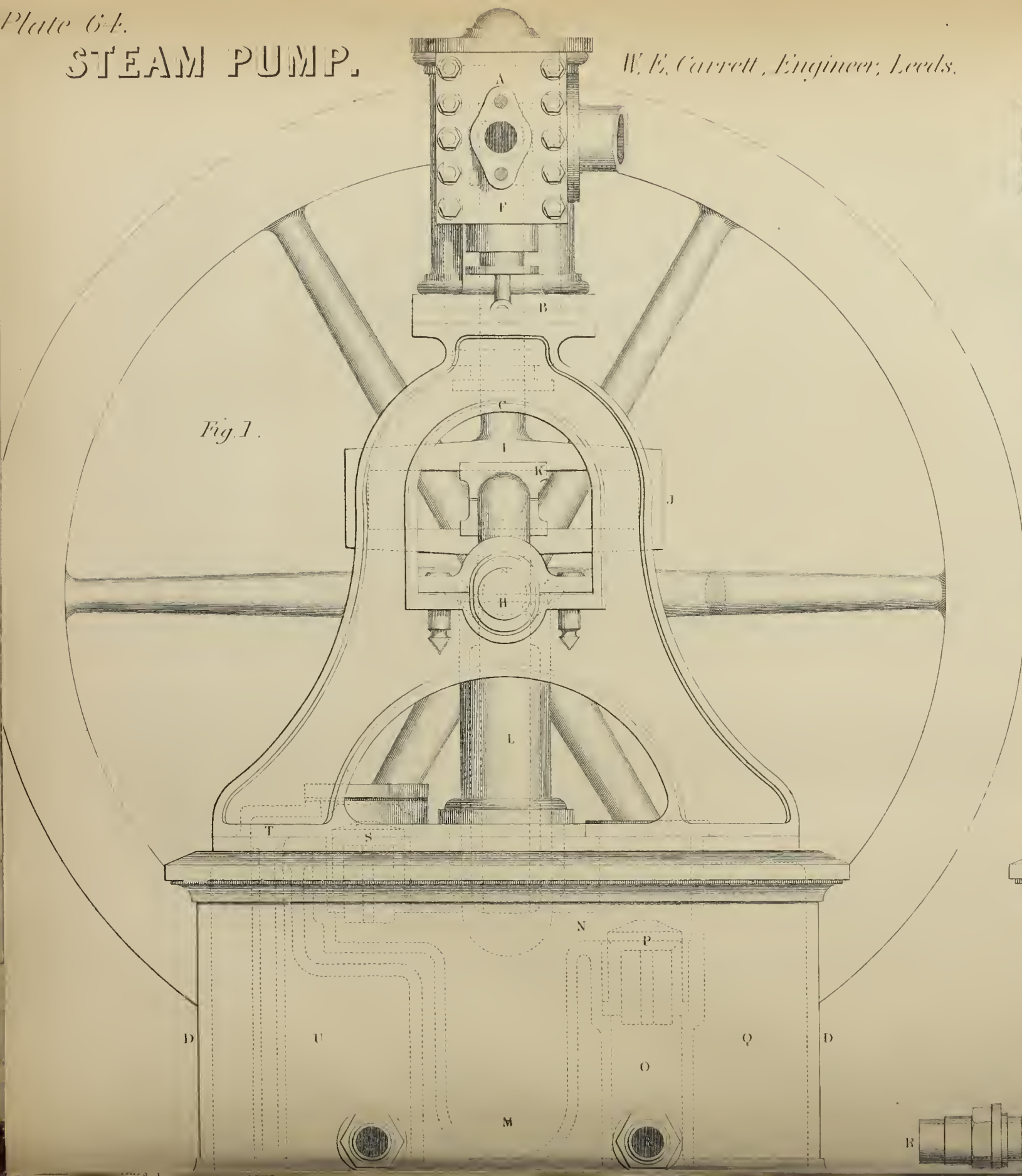
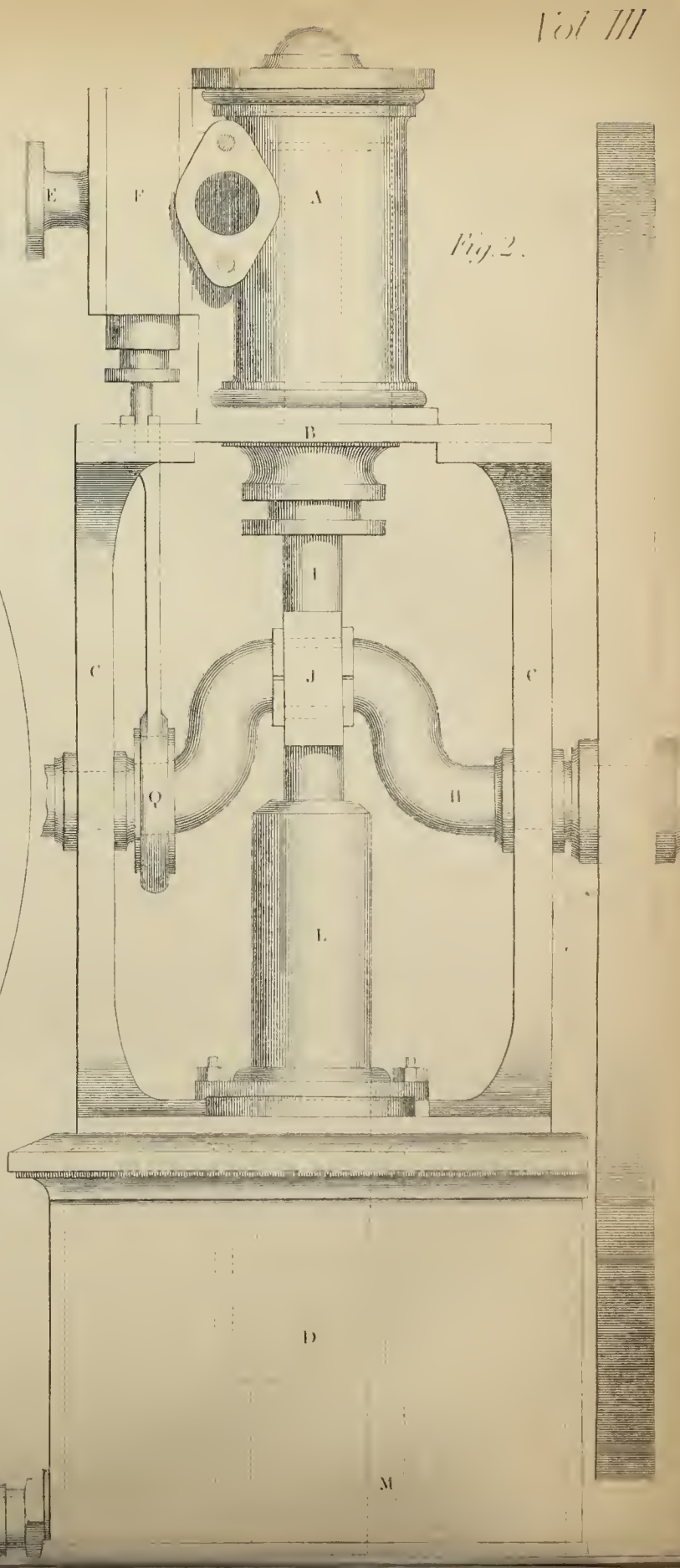


Fig. 2.



enable them to multiply and endure for an appointed period, and occupy an appointed station on the globe.

After pointing out the strict dependence of each species of animal and plant, on certain physical conditions in the state of the earth's surface, and on the number and attributes of other organic beings inhabiting the same region, he shows that all these conditions are in a state of continual fluctuation, the igneous and aqueous agents remodelling, from time to time, the physical geography of the globe, and the migrations of species causing new relations to spring up successively between different organic beings. He deduces, as a corollary, that the species existing at any particular period must, in the course of ages, become extinct, one after the other.

CARRETT'S STEAM PUMP.

(Illustrated by Plate 64.)

The mechanical arrangement to which Mr. Carrett, the inventor, has given the name of "Steam Pump," is a clever example of the application of steam power for lifting or forcing water under any pressure, and for every variety of purpose. It supplies an important want so frequently experienced in engineering and manufacturing works, of a ready means of lifting and conveying water supplies, without involving the trouble and expense of fixed machinery of complicated construction.

Our engraving, plate 64, represents two views of the pump, constructed to deliver ten gallons per minute, at a height of 120 feet, the steam power being derived from a two-horse portable high-pressure boiler, complete in itself, and weighing under 6 cwt.

Fig. 1 on our plate is a front elevation of the pump and actuating steam cylinder, and fig. 2 is a corresponding side elevation or view at right angles to the first figure. The steam cylinder, A, is inverted upon the horizontal plate, B, which is bolted to the top of the two standards, C, forming the framing of the machine. These standards spring from the chest, D, which answers as the base of the whole, and contains the influx and efflux vessels for the water. The branch, E, conveys the steam to the slide-valve chest, F, which is arranged in the simplest manner, the slide being worked direct from the eccentric, G, on the crank-shaft, H. The crank-shaft is carried in two bearings in the cross-piece of the side standards, and is connected to the piston-rod, I, of the steam cylinder, by passing the cranked portion, fitted with a steel slide, J, through the horizontal slotted cross-head, K, of the piston-rod. The latter is prolonged below the cross-head, for the purpose of carrying the water-plunger, L, which is bored out and entered upon the rod, and secured by set screws. When the engine is not required for pumping, the plunger is disconnected by slackening these screws, and the piston-rod then works loose inside the plunger as a guide, the power of the engine being then devoted to driving other machinery by a belt on the fly-wheel, or by connecting the crank-shaft with the machinery to be driven, by means of a link or universal joint, which, in our plate, is supposed to be broken away. The whole of the pump-work is shown by sectioned dotted lines in the base chest. The pump cylinder or barrel is at M, in the centre, and the passage, N, at the top, forms the communication with the vertical influx water passage, O, governed by the conical lift-valve, P. The bottom of this passage opens into an air vessel, Q, which, with the corresponding vessel for the discharge on the opposite side, forms the chief feature of improvement in the arrangement. The water is taken in by a pipe attached by a union joint at R, to the base chest. The discharge is by the opposite port, fitted with the lift-valve, S, which opens into the top passage, T, communicating with the top of the discharge air vessel, U, which has a discharge pipe attached at V.

It is this neat combination of air vessels, with the influx and efflux passages, which enables the pump to be worked at an effective speed, without injury to the different movements, whilst a constant and regular delivery is completely secured. Without a provision of this nature, the barrel of the common pump is only partially filled at each stroke, and the ram is consequently driven against the surface of the water with a serious shock at each down stroke. On the other hand, in Mr. Carrett's pump, the lower valve, at each ascent of the plunger, drains its water supply from the bottom of the induction air vessel; which again is fully replenished by the suctional power from the reservoir. When the plunger descends, the water in the barrel is driven through the upper valve into the discharge air chamber, and makes its escape thence in a "continuous stream," under the pressure of the contained air. Thus, the pump has a noiseless and perfectly smooth action, with a uniform delivery.

Our plate shows the old slotted cross-head movement, as adopted for returning the plunger at each termination of its stroke, and for this purpose, as there is no great strain on the working parts, this simple plan has met with an apt application. For powers of pumps from three horses upwards, a connecting rod and vertical slide movement is substituted, and this of course is a much more suitable arrangement, where the engine is intended occasionally to exert its power through the crank-shaft.

The slotted frame is not, however, a mere aperture, as in the original plan adopted in steam-engines. A thin metal plate is bolted on each side, so as to provide projecting edges as guide flanges for the slide block, and to retain the lubricating oil on the surfaces where it is wanted.

For the works of the contracting engineer, the liquid-forcing operations of the farm-yard, and the multifarious uses of manufacturing establishments, this pump is peculiarly applicable; and the inventor proposes also to apply it for working cranes on the hydrostatic principle, or hydrostatic presses, in which situations a small machine of three cwt. is able to accomplish the united work of eight or ten men.

It is perhaps hardly necessary to point out the peculiarly fitting application of this pump as a feeder of water to any kind of boiler, locomotive, stationary, or marine, as it may be adjusted to work under any pressure at a uniform speed, and is capable of fetching or forcing water any distance without shock or concussion to the pipes. In the ordinary pump, this must be accomplished by the expensive application of a trio of lesser pumps, driven by a three-throw crank.

We may add, that Mr. Carrett has obtained legal protection for his ingenious compound engine and pump, and we have little doubt that its cheapness and aptitude of purpose will secure for it an important place in the practical economy of engineering.

ON THE PROPULSION OF STEAMERS.

I.

We have already given, at pages 102 and 124, an elaborate paper "On the Paddles of Steamers," &c., containing the valuable deductions of Mr. Ewbank, from the numerous experiments and observations which he has made upon this important subject. In following out the various links of the chain of reasoning into which he has entered, we now give some additional observations and illustrations, which will be found elucidatory of obscurities scarcely looked into by English engineers. From the collection of natural aquatic and aerial propellers, much information is to be gleaned as to the questions of the form and arrangement of artificial propellers.

The principles by which steamers are to be impelled over oceans with rapidity and economy of power, are as definite as any that give effect to a lever or screw, and as fixed and unalterable as those of nature herself. To discover them is the business—the chief business—of the philosophical engineer, and not till this is done can his achievements be free from the taint of imperfection and corresponding failure. It is discreditable that the true outlines of propelling blades have not been determined, and the rather since it is a proof that the full bearing of the question involved has to be felt—that the potential influence of form and proportion in propellers, as well as in the hulls of steamers, has yet to be investigated.

In the following illustrations are a few out of millions of gradations of form—from the slowest to the quickest—which show that the greater the velocity, the longer, narrower, and sharper they are; and the converse, as speed is diminished, the shorter, wider, and blunter they become—the same rule applying to ornithologic as to ichthyological organs of motion. There is something exceedingly interesting, as well as instructive, in marking the changing outline—in observing that fish, *e. g.*, improve in speed as their *rounded and undivided* tails emerge into a *triangular* figure; next, as they become *indented;* and lastly, *lobated* and *pointed*, the quickest of all.

Such appears to be the general process, subject of course to many modifications, in order to meet the requirements of diversified habits and instincts. Still, wherever a fish is seen with a round or roundish and unbroken tail, it may safely be set down as a comparative slow mover; while deeply indented ones are, without exception, indicative of rapid flight.

Round and Roundish Propellers.—The cat-fish, an inhabitant of most of our rivers, common in the Potomac, and its habits well understood, is selected as a fair representative of slow movers, since there are probably as many species inferior to it in this respect, as there are that excel it: fig. 1. The general contour of this fish does not seem unfavourable to speed; the propelling blade is also very large in proportion to the body, notwithstanding its movements are comparatively slugged.

GROUP I.

Is dedicated to slow and comparatively slow swimmers. Fig. 2 is the caudal fin of the sole, found in most of our Atlantic streams. The propelling blade is here almost a perfect circle, while in the kindred flounders it varies from this to a sharp triangle. The idea of activity, or of a moderate speed, is never associated with these tribes, nor could it, since they are among the poorest of aquatic rangers.

Fig. 3: The agriopus—a type of blade common to shoals of indifferent swimmers. Not a few of the Chetodons—ocean's butterflies, as they have been named from their brilliant and variegated colours — and other inactive occupants of tropical seas, have propelling oars formed after this pattern. The instrument wielded by the toad-fish of the U. S. coast is not unlike it, only more elongated; while other families have it forming a mean between the two. Both flounders and toad-fish, for lack of speed, often seize their prey by stratagem; covering their bodies in mud or sand, no sooner do their unsuspecting victims come within reach, than they are seized and swallowed.

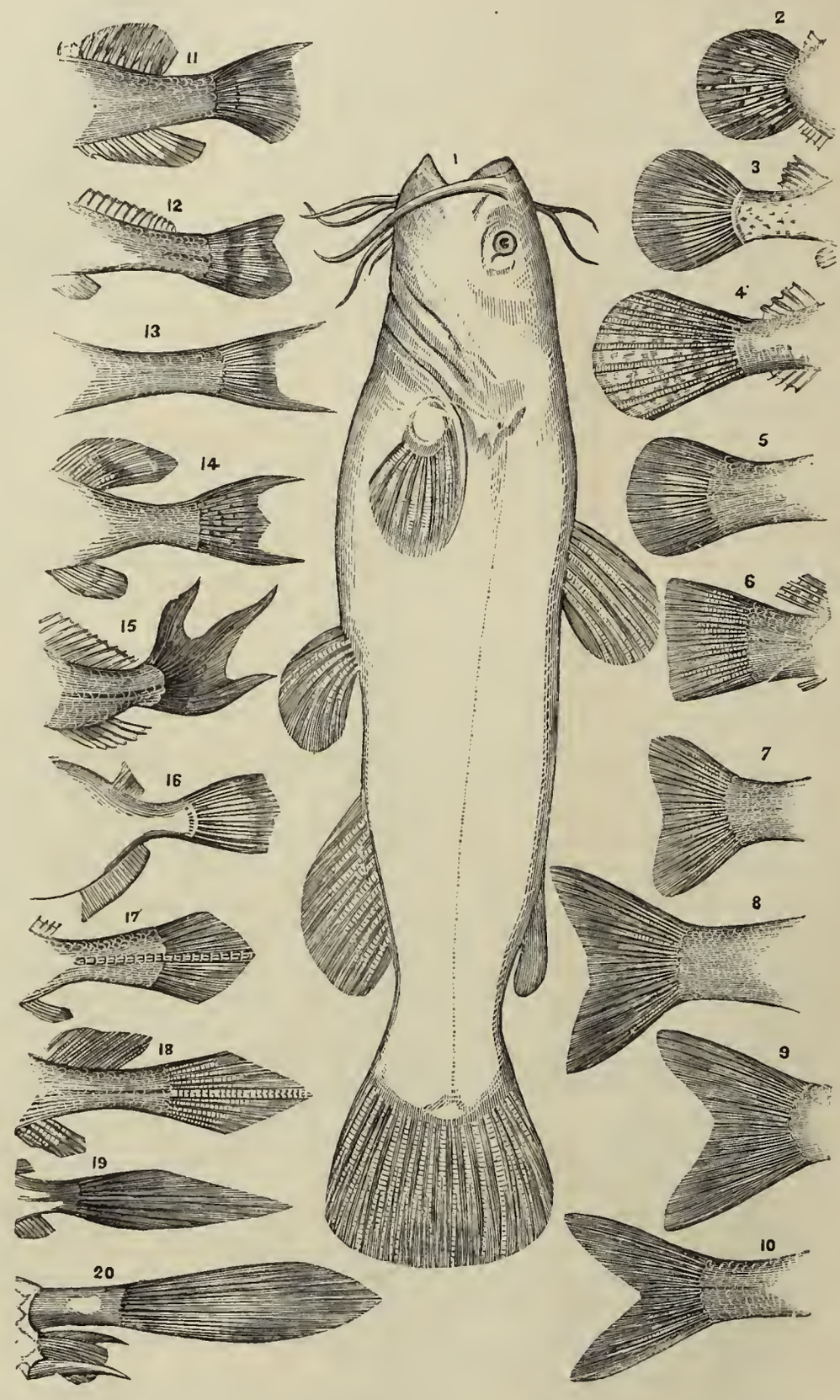
Fig. 4: The pelor of Japan, from Cuvier—another of the toad-fish family. Here the outer rays are lengthened and nearly straight, while the posterior margin preserves the rounded form.

Fig. 5: A perch from Cuvier. The body is apparently adapted for quick flight, and has a large area of propelling blade; but the rule or law assumed is not here violated. This fish is far from being a rapid mover. The form of blade is very common; the curve of the posterior boundary being more depressed than in the preceding, and but slightly more convex than in the jaculator. This last fish is an expert gunner, but an indifferent swimmer. Feeding on insects that hover about aquatic plants he shoots them with pellets of water ejected from his mouth, and generally with certain and deadly aim. His speed is greater than the preceding, but less than

Fig. 6: The lettered serranus. A type of *triangular blade*, and of quicker swimmers than the preceding; one common to myriads of finny tribes. Convex boundaries have here all but vanished, the exterior rays of the organ being the longest, and the posterior margin nearly a right line. In the striped bass or rock-fish, and in the southern kingfish, this margin becomes slightly concave, in which respect they represent a great variety of fishes.

Increased speed accompanies the *triangular* and *indented*. In the yellow perch, fig. 7, this form of outline begins to appear; the posterior margin being cut away so as to present the nuclei of lobes. Now this familiar fish is known to be, what the contour of its propeller declares it should be, far less agile and swift than its kindred and constant associate, the white perch, whose caudal fin is shown at fig. 8. Both are taken at all seasons, in the Potomac. Fig. 9 is the sucker or mullet of the same river, and fig. 10 the smelt, whose caudate lobes are still further brought out, and whose superior activity in the water is known to every angler.

GROUP I.—SLOW AND COMPARATIVELY SLOW SWIMMERS.



GROUP II.

Lobated and Pointed.—In this series this progressive development of motive lobes is continued up to those of the swiftest of known swimmers. A mere glance at the figures in connection with those just described, will suffice to show how invariably and uniformly speed is accelerated by lengthening and pointing the propelling organs. (The figures are not drawn to one scale.)

Fig. 1: American herring, and fig. 2, the shad—both too well-known migrators to need remark. The sketches are, like most of those in Group I., from nature.

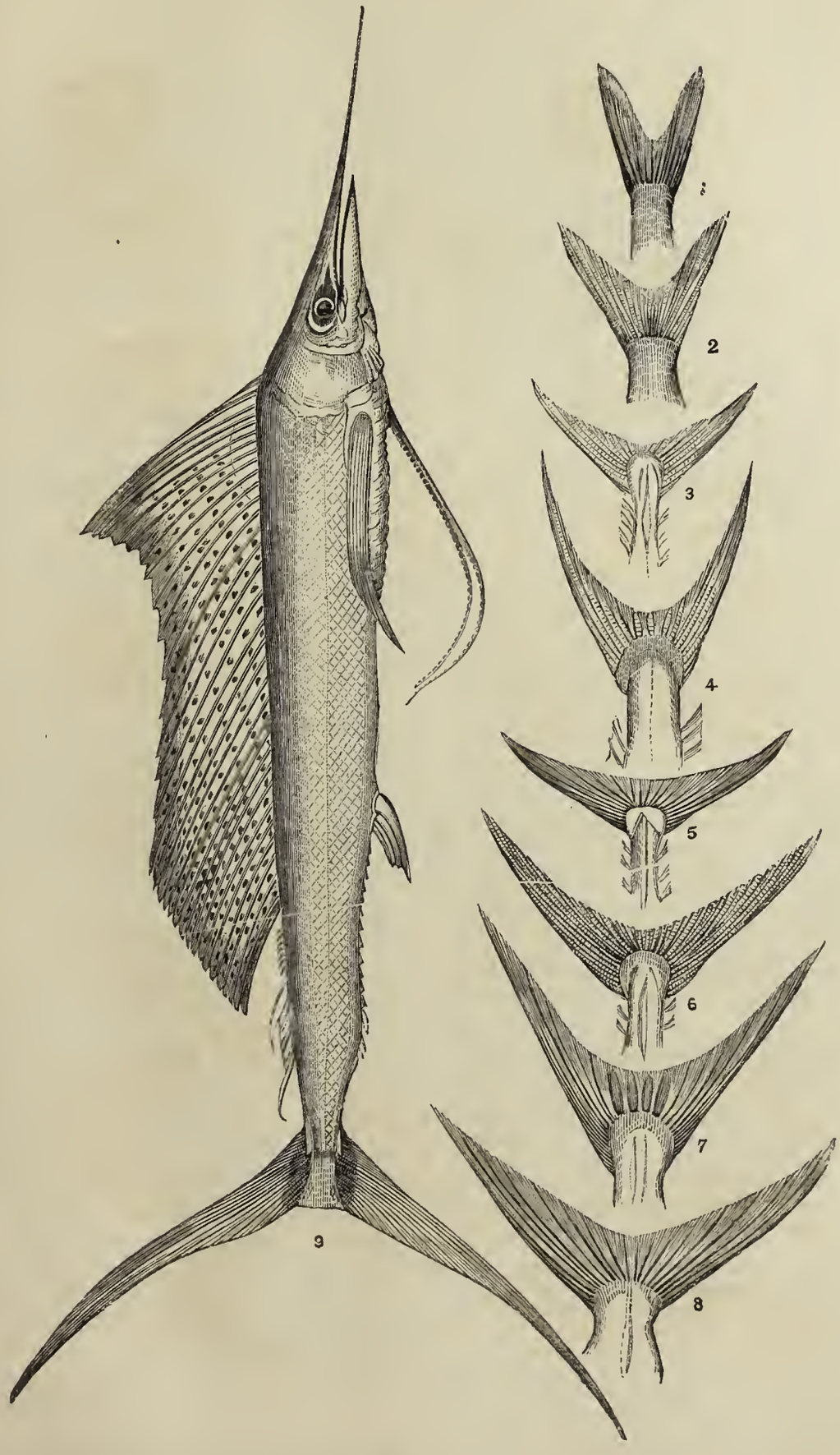
Fig. 3: The mackerel. A family known to have great power in the water, and to swim with what has been termed incredible energy. It has a wide geographical range—some are supposed to cross the Atlantic from the Mediterranean, and, visiting our coast, are met with from Maine to Florida.

Fig. 4: The dolphin. Accounted among the swiftest of swimmers. Excessively voracious, it hunts its prey with impetuous speed, and is a terrible enemy to flying fish and other aquatic game. It plays round ships under full sail, and apparently without effort. A specimen in the National Collection measures two feet from the nose to the point of lobal divergence. The lobes are ten inches long, and only one and a half wide at their junction; they are somewhat nearer to each other than in the living fish.

Figs. 5 & 6: The bonita and tunny. Well-known marine foragers, from whose theatres of depredation few of their prey can escape by flight. Both are allied to, and formed on larger scales after the mackerel model. The lobes are divergent, those of the former nearly at right angles to the body.

Figs. 7 and 8: Sword-fishes. The first common in the Atlantic, and with its sharp and elongated lobes, rapid flight is instinctively associated. The momentum acquired by it may be imagined from the fact of its weapon having been repeatedly driven through the solid timbers of ships. The latter is from Cuvier. In these creatures their whole power is concentrated in the caudal fins, and enables them to rush on their prey with the impetus of falling meteors. Of varieties, the East Indian sword-fish, figured at large (fig. 9), surpasses all others in velocity, and the force with which it transfixes its victims. The chief use of its high dorsal fins is to steady the body in the line of its flight.

GROUP II.—LOBATED AND POINTED.



The air and outline of the body of this remarkable creature, with its long, tapering, and acuminated propelling lobes, impart universal conviction of its powers of flight, just as the reverse impression is felt on viewing any of the slugged movers. Were the space between its blades filled up, it would at once become one of the latter, and, without an accession of motive energy, one of the slowest among them.

Fish, like birds in the atmosphere, are impelled onward by a succession of impulses. When the fins strike slowly, the resulting starts or bounds are observable; but in high speed the strokes follow each other in such quick succession, that an apparent uniformity of motion is the result.

Laying out of view all sculling action, let the broad and undivided lobe, A, (the lower figure in the marginal cut,) be in the position in which it is prepared to push the fish forward, viz., to unbend and bring itself to a line with the axis of the body. Now, in doing this, the extreme posterior margin passes through a greater space in the same time than those parts near the body, and consequently produces the greatest effect. If this margin had no slip, then those parts would be absolute impediments, and a portion of the power would be uselessly consumed in forcing them laterally against volumes of water, whose reaction would not further the progress of the fish. Were such organs rectangular and inflexible boards, this would at once be obvious; it would then be seen

that the parts towards the body, instead of assisting, would be positive hindrances. What such boards would be to fishes, they are, in fact, to our steamers, although having little dip, the evil is not so apparent in them.

It is conceded, that where the organs are very short, this obstruction nearly vanishes; but, with such, high speed cannot be attained for want of sweep, while with long and broad ones it is realized only with a surplus expenditure of vital force. A most beautiful compromise between the two has therefore been devised, viz., *caudate lobes*, in which the central and obstructing portions of undivided blades are removed, the sweep increased, and a maximum velocity obtained with the least possible amount of propelling surface, and at a minimum expense of motive power. This is the way nature makes her fast swimmers, and it is the one by which we should construct ours.

Although the lobe, A, has been alluded to as describing a curve in the water while unbending itself, in practice it is hardly so; at any rate not when a quick-going fish is at its maximum flight. The organ then acts more like an elastic substance rebounding from a wall; for its action against the fluid is so rapid, that the latter has not time to yield ere the fish has shot forward to the second position at B, and is in the act of taking another stroke. The lobes, in thus unbending, follow up their first impulses somewhat as do bowstrings the arrows shot from them.

Unequal Lobes.—Those just described enable their owners to progress with equal velocity in all positions, each pair being uniform in dimensions and outlines: but suppose groups should exist whose habits and instincts require them to dart faster through the ocean in some courses than in others, we might then expect corresponding changes in their blades, and such changes should either confirm or shake the position assumed. Now there *are* those, and among them conspicuous occupants of the deep, which can only fulfil functions assigned them in the economy of nature by travelling quickest in particular directions. How are they enabled to do this? By novel forms, or by new arrangements of motive organs? No, but by a device which, like an *experimentum crucis*, establishes the principles contended for.

Fishes that hunt their prey, or escape from their enemies, in courses *inclined* to the *horizon*, are provided with unequal blades; those from which increased vigour in the destined directions is to come, being most developed. Thus, classes to whom the highest speed is essential in descending, have the superior lobe prolonged; while in such as fly or forage upwards, and consequently to whom a maximum velocity in that direction is indispensable, the inferior one extends beyond its fellow. Furthermore, the degree of inequality is proportioned to the angles formed by the lines of ascent and descent with the horizon. In this very remarkable provision for enabling certain groups to move with the greatest rapidity in the direction most essential to their existence, we have collateral evidence, extensive and emphatic, in support of the proposition, that the more rapid the flight, the longer and narrower, within certain bounds, must be the blades of propulsion.

This inequality in motive organs is believed to be unique: nothing like it occurs in other departments of nature. Both wings of a bird or of an insect are uniform—identical in contour and proportions. So also the paddles of swimming birds and of amphibia. In none does one of a pair exceed in dimensions the other. To this singular deviation, so illustrative of artificial as well as natural proportion, Group III. is dedicated.*

* The series of six groups will be continued next month.

POSITION OF GLASGOW IN THE GREAT EXHIBITION.

"Those states which remain behind in general industrial activity, in the selection and preparation of natural substances, in the application of mechanics and chemistry—and where a due appreciation of such activity fails to pervade all classes—must see their prosperity diminish;—and this the more rapidly as neighbouring states are meanwhile advancing, both in science and the industrial arts, with, as it were, renewed and youthful vigour."—ALEXANDER VON HUMBOLDT.

With the prospect of the exhibition of the produce of the world's industrial art before us, we might almost assume that, when the great author of Cosmos penned the lines we have just quoted, he had in his mind's eye the possible consummation of this grand project. If he had not, he will feel that his earlier ideas will, in these later days, fall on the ears of the world with a far more telling force than his most imaginary dreams could have foretold. The laggard manufacturer, in his walk through the exhibition building, will have new energy imparted to him by the vivid exemplification of the miserable condition of those who "remain behind in general industrial activity." The active man of science or commerce will rejoice to see that his untiring efforts have placed him foremost in his pursuit, and he will be able to satisfy his own conscience that he is "advancing both in science and the industrial arts, with, as it were, renewed and youthful vigour."

In the midst of the crowded lists of contributions of examples of the industrial produce of the three kingdoms, Glasgow has, so far, given no specific sign of the position she means to take as an exhibitor. Let us then inquire how this vast centre of mercantile enterprise intends to be represented. In the first grand division—

SECTION I. Raw Materials and Produce—illustrative of the natural productions on which human industry is employed—

We find that 17 exhibitors have stood forward. Their contributions consist of examples of iron and the leading minerals of the district, with a complete collection of the great range of chemical productions for which the city is celebrated. The total area demanded for this class of articles amounts to 622 square feet.

In SECTION II. Machinery for Agricultural, Manufacturing, Engineering, and other purposes, and Mechanical Inventions—illustrative of the agents which human ingenuity brings to bear upon the products of nature—

Thirty-nine exhibitors are enumerated. Of these, 8 are contributors of agricultural machines. In these articles are comprised—ploughs of various kinds; drill-grubbers; parallel grubbers for working on the flat; thrashing-machine; farm carts; flexible trussed tubular iron swings, or yoke; equalizing horse-yoke, for working abreast; parallel expansion horse-hoe, for drill crops; parallel lever subsoil pulverizer; hummeller; grain and grass seed sowing-machines; and a reaping-machine. The space required for these contributions amounts to 2,651 square feet.

Of articles of all kinds coming under this section—not being agricultural machinery—there are machinery illustrative of the application of water as a moving power; rotatory steam-engine; working model of a compound marine steam-engine, driving a patent bobbin turning-machine; safety cage and detaching catch for mine shafts; hydrostatic press; beer pump; canal elevator, a substitute for the common lock; lift apparatus for sunk ships; goods lift for railway stations; hydro-pneumatic pump; surgical instruments; nautical azimuth and compass; indicating level; steam and vacuum guages; mathematical and nautical slide-rule; elastic-faced valve-cock; water-closet; mule for cotton-spinning; iron braces, and tools for boring; planes and edge tools; improved winding-machine for yarn; system of permanent way for a railway; elevating-machine for firemen, and fire-escape; railway turn-table; improved canal lock; mould-making machine for cast-iron pipes; patent lactarine for fixing pigment colours on woven fabrics; cranes for erecting breakwaters; lithographic press; model showing the mode of extrication of the Great Britain steam-ship; spelf-machine for designers for calico-printers; double-acting vibrating compressed air alarum for railway trains; double-acting safety valve and whistle, with steam indicator; semi-gravitating steam-engine; and a model of omnibus and horses. Space required, 2,209 square feet.

SECTION III. Manufactures—illustrative of the result produced by the operation of human industry upon natural produce.

In this—the grand division of the series—the number of exhibitors is 96. The chief varieties of the textile manufactures of the district are well represented in this class—as, sewed muslins; ginghams; checked handkerchiefs; lappets, and loom-figured fabrics; printed muslins and calicoes; galas; diapers; shawls; embroidered dresses; cotton yarns, dyed

and grey; woollen tweeds and tartans; robes de chambre; zebras; turkey-red printed cottons; cut-pile carpeting and hearth rugs; pullicates; specimens of thread manufacture, and embroidered silk lace veils; cloth, the woof being the unbroken fibres of Manilla hemp; muslin curtains; silk bandana handkerchiefs; needlework, cotton and linen shirt and cap; fancy needlework, in Berlin wool and silk; and waterproof clothing and tarpaulin.

Of manufactures not appertaining to the textile class, there are—an electro-stereotype plate; specimens of novel designs in electro plate; cutlery; gasaliers; screw bolts; a gas apparatus, and examples of castings; terra cotta, and earthenware pipes; fire-clay bricks; salt glazed water-pipes; chimney cans; vases; fire-clay jet d'eau; china and earthenware; painted and gilded glass for a table top; ornamented clock face and panel; strawplait and hats; chiffonier, loo-table, and tea-caddy; power-loom shuttles; casks made by machinery; telescopic and collapsing canopied bedstead; machine-made nets for the herring and mackerel fishery; Scotch cart-horse harness; bookcase; hide and leather ropes; artificial flowers of silver and silk; new portable umbrellas; machine-made Scottish confectionery; life-buoys and floating mattresses; and pirns. The space required is 13,228 square feet. We have now arrived at

Section IV. Sculpture, Models, and the Plastic Art generally—illustrative of the taste and skill displayed in such applications of human industry.

This class has 10 exhibitors, the articles being—a carved mirror frame; die-sinking; water-colour design for a ceiling decoration; letterpress printing in two or more colours; a book illustrative of Scottish binding and printing; examples of various kinds of penmanship; drawing of an improved locomotive and tender; model of the royal arch at Dundee; models, with cases, of artificial teeth in gold and palladium; chromolithography; and a mounted ram's head. The area demanded amounts to 104 square feet. The total space demanded is 18,814 square feet.

These particulars merely exhibit a rough outline of the matter under review, but they are probably sufficient to show the extent to which Glasgow has come forward. If there is room for regret that some branches of production are feebly represented, there are, on the other hand, some substantial reasons for our presumption that what has been accomplished will be to the credit of the Scottish industrialists.

The anticipated success of the show of 1851 will lead, it is to be hoped, to a second filling of the exhibition building; and the experience gathered at the first, will probably embolden Scottish producers to follow up their present efforts with something better. If we were to balance up the two accounts of what is actually done in the district, and what is to be represented in Hyde Park, many grave deficiencies would come out in the latter statement. Let us, in the first place, see the result of the great experiment; we may afterwards indulge in a prophecy as to what will be thereafter accomplished.

THE MECHANIC'S LIBRARY.

Arithmetic Rules and Reasons, 12mo, 2s. 6d. J. H. Boardman.
Art-Journal, The, vol. for 1850, imperial 4to, £1 11s. 6d. cloth.
Architect and Contractor's Pocket-Book for 1851, 12mo, 6s. roan tuck.

Chemical and Pharmaceutical Manipulations, 8vo, 14s. Morfitt.
Correlation of Physical Forces, 2d edition, 8vo, 5s. cloth. W. R. Grove.

Dynamical Theory of the Formation of the Earth, £1 12s. Ritchie.

Elements of Physical Geography, map, 18mo, 1s. cloth. Hugo Reid.
Elementary Mechanics, 8vo, 10s. 6d. hds. J. B. Phears.
Engineer's Pocket-Book for 1851, 12mo, 6s. roan tuck. Weale.

Fine Arts Almanac, &c., for 1851, 12mo, 1s. sewed.

Geology, crown 8vo, 2s. 6d. cloth. Dean Cockburn.
Gothic Ornaments, 209 plates, 2 vols., £7 10s. cloth. J. R. Colling.

Hints to Inventors intending to obtain Letters Patent for their Inventions, or to protect their Designs by Registration, 4th edition. Wm. & J. H. Johnson.

Literary and Scientific Register and Almanac for 1851, 3s. 6d. Gutch.

Manual of Natural Philosophy, Part 1, Galbraith and Haughton's Mechanics, 12mo, 2s. sewed.
Müller's Ancient Art, from the German, by Leitch, 2d edition, 18s.

Rural Chemistry, 3d edition, 12mo, 5s. 6d. cloth. E. Solly.

Shipmaster's Guide, The, new edition, 12mo, 2s. 6d. sewed.
Skyring's Builder's Prices, 1851, 8vo, 4s. sewed.

Treatise on Dynamics, 8vo, 9s. 6d. cloth. W. P. Wilson.
Treatise on British Mining, 8vo, 4s. cloth. T. Barlett.

Timothy Hackworth

The name of the engineer whose portrait heads the present memoir—closely wedded as it is with those magnificent strides towards the perfection of railway locomotion, which we, the dwellers in the first half of the nineteenth century, have experienced—has attained an eminently proud position in modern mechanical history. We need merely refer to our "Chapter in the History of Railway Locomotion,"* to show that his connection with that branch of practical science, which he did so much to advance, dates from a time when mechanics had very feeble pretensions to the rank of a science. The same paper, in its illustrations of the "Sanspareil," is unmistakeable evidence of the successful result of his labours, and of the amount by which he left the pursuit better than he found it.

Timothy Hackworth was born at Wylam, a small village on the northern bank of the Tyne, west of Newcastle, and contiguous to the ancestral seat of the Duke of Northumberland, on the 22d of December, 1786. His father, who enjoyed no inconsiderable reputation for his skill in boiler-building and mechanical construction, held the foremanship of the smiths at Wylam colliery. There is, in fact, an historical line of descent in the family, with regard to the occupation which formed the basis of his profession. Like other village youths, he was initiated into the mysteries of the rudiments of education by the village schoolmaster, and, at the age of fourteen, was apprenticed as a smith at Wylam colliery.

The distinctive features forming the inherent qualities of his mind were early displayed in an aptitude and acuteness in mechanical construction, which brought him considerable repute; and the passionate ardour with which he grasped at a thorough knowledge of his art, formed a pleasurable theme for his father, who, however, died when his son was no more than 16 years old.

His sensitive nature acutely felt this mournful deprivation, and he thenceforward had to discharge the duties of father and protector to the surviving family. On the completion of his apprenticeship, he was raised to the rank of foreman smith, and took a very prominent part in the introduction of the locomotives at Wylam colliery, the fame of which having reached the ears of the colliery owners, they determined to make trial of

* Page 49, *Practical Mechanic's Journal* for June, 1850.

the newfangled power for conveying the coals from Wylam to Lemington. For this purpose, one was ordered from Messrs. Trevithick and Vivian; but it is matter of local history that this engine never reached its destination: being tried at Newcastle-on-Tyne, the experiment proved its destruction, and, instead of proceeding to Wylam, it was employed in a foundry at Newcastle.

Although thwarted in this, the spirited owners yet determined to prosecute their original plan, and Wylam became the theatre of locomotive experiments. Up to the period of which we speak, Mr. Hackworth's experience and practice had been chiefly confined to colliery operations, and it was not until the latter end of 1811, that he first took part in locomotive mechanics, when he assisted Mr. T. Walters in building the first locomotive ever employed at Wylam. The boiler was of malleable iron, with cast-iron ends, and dragged its load by the adhesive power of the wheels. These were the days of one-cylinder-and-fly-wheel locomomotives. This engine, although of some note as a first production, was of questionable utility. Immediately after this, another engine was built by Mr. Hackworth and Mr. Jonathan Forster, in which considerable improvement was made. The fly-wheel was abandoned, and two cylinders were applied, fixed at the boiler sides, and working with levers, and giving out the power to the wheels by an arrangement of spur gear. The generative steam power of the boiler was far from complete, yet the success of this engine was considerable, as she was capable of taking a load of from 12 to 16 chaldron waggons on the distance of four or five miles, from Wylam to Lemington. Others were made, and the then novel machines, christened the Dillies, took the place of the horses and bullocks hitherto employed, the interest and astonishment which they excited being only equalled by their successful adaptation. Engines on this plan, with very little variation, may still be seen regularly working on the Wylam railroad. The great success attendant upon these experiments gave an impetus to the system, and the other colliery owners in the north were led to its adoption. Those of Kenton and Fawdon collieries had two locomotives manufactured by Messrs. Fenton, Wood, Murray, and Jackson, of Leeds, on Mr. Blenkinsop's principle—a rack rail being extended the whole length of the line, into which spur wheels, driven by the engine, worked, and thus produced locomotion. After this, a locomotive engine was made at Killingworth colliery by Mr. George Stephenson, which, like those at Wylam, worked by adhesive power. She was tried in July, 1814. Thus the machine was rapidly introduced in those districts.

It was at Wylam colliery that the efficiency of the adhesive principle for locomotive engines was first demonstrated, the application being undoubtedly due to Mr. Hedley, the colliery viewer. He first had a machine made and worked by manual power, to ascertain how much weight its wheels would overcome; then, by comparison of the weight of the machine to the load, found how many carriages the locomotive engine would drag by its adhesion upon the rail. This machine, as well as a small model, was made by Mr. Hackworth; and the model, yet in existence, was exhibited at the last Polytechnic Exhibition held in Newcastle.

About this period, an incident occurred which strongly exhibited Mr. Hackworth's rectitude and integrity, for, having been requested to do a piece of work on the Sunday, he firmly declined, on the ground of the sacred character of this day. In consequence of this, he removed to Walbottle colliery, where he obtained the foremanship of the smiths, which he held with distinguished merit.

In 1824, Mr. George Stephenson, who had commenced a manufactory at Newcastle, desired the agent of Walbottle colliery to lend him Mr. Hackworth to superintend this establishment during the time he was surveying the Liverpool and Manchester Railway. This was granted, and the borrowed engineer undertook the management. In this capacity, his energy and perseverance, combined with his manly talents, raised him into honourable notice, his position affording a wide field for their display. On Mr. Stephenson's return, he was very anxious to retain Mr. Hackworth in his service, and offered him considerable inducements to continue—even half his own interest in the manufactory. For reasons best known to himself, he declined this proposal.

At this time an exploring expedition to the gold and silver mines of Venezuela, Trinidad, and New Granada, was started in the neighbourhood, and the superintendence was offered to Mr. Hackworth; but he declined its acceptance, and Mr. R. Stephenson undertook the charge.

After the completion of his engagement with Messrs. Stephenson and Co., he was for some time engaged in building boilers for the Tyne Iron Company; and had taken an establishment in Newcastle, intending to commence business on his own account, having obtained several orders, when he was induced, through the agency of Mr. George Stephenson, to accept the office of resident engineer and general manager of the Stockton and Darlington Railway, in consequence of which his intentions were prematurely abandoned, and in June, 1825, he removed from Newcastle to Darlington. Then began that laborious research and vigorous investigation of the principles of locomotive mechanism, with a view to their adaptation to the requirements of public traffic; and how well he succeeded, was admirably attested by the general celebrity of the locomotives upon this line. His duties were of a most arduous and fatiguing character, such as can scarcely be conceived at the present time, considering the then raw state of everything connected with railways; without any assistant so far acquainted with the system as to sustain a part of its duties, almost the entire guidance and direction devolved upon himself. The herculean labours which he performed during this epoch in railroads, marked the force of mind which could gather mere fragments of ideas, and unite their disjointed parts, working out of them a beautiful and effectual system of public conveyance.

The general inferiority of the locomotives first employed rendered the question of practical adequacy doubtful. Whether iron-muscled, steam-animated joints, or dame Nature's most useful brutes, were to have the ascendant in railway propulsion was resolved by him. He saw and studied the imperfections which deteriorated their efficacy, and by remedying those in a master-stroke of his own, settled the question of expedieney between the rival forces. The locomotive forces on the Stockton and Darlington Railway, worked on an extent of 20 miles, whilst five miles of the line consisted of inclined planes, in which stationary engines were employed. Among the many contrivances in railway machinery, stand conspicuous the double-acting drums for incline planes, first put down on the Brusselton Incline in 1826.

In order clearly to understand the importance of this invention, it will be necessary to give some account of the old drum, which was superseded. Hitherto the practice was to have only one drum, which was fixed vertically, working each side of the incline alternately. Those conversant with mechanics can alone appreciate the value of Mr. Hackworth's invention, for it will be apparent to practitioners that a great loss of power was consequent on the old mode, as the whole of the work had to be done by the engine. Not only was it very slow, but great difficulty was experienced in getting the rope to coil properly upon the drum, which it was necessary to watch and keep right with a crow-bar. In the place of this he put down the double-acting drum—two drums on one horizontal shaft. The diameters of the drums being proportionate to the respective lengths of the inclined planes, the momentum of the descending waggons considerably aided the engine in hauling the ascending waggons.

A far greater improvement still was the alteration which he made in the drum of the Etherley Incline, immediately after. Here, the laden waggons having to descend the long bank, their momentum was such as to draw the laden waggons up the short bank, irrespective of the power of the engine, the latter being only required to draw the empty waggons up the long side, and had the assistance of the empty waggons descending the short bank on the other side.

Another simple and ingenious instrument was the discharge-hook, or dog, for instantly detaching the rope from the waggons without stopping, as well as the drag-frame, or cow, attached to the last carriage of the train whilst ascending the incline, to arrest its destructive descent in case of rope breakage. Another useful provision was the switch, fixed a short distance from the top of the incline, and having a rod connection to a lever at the top, by which the waggons could be thrown off the line when they happened to run over the bank-head. By a similar arrangement at the bottom, they could be thrown off when they chanced to escape the first switch, and prevent a collision with the waggons at the foot of the incline.

A great achievement in mechanics was the "Royal George" locomotive engine, which will ever remain an enduring trophy of his powers. Considering the comparative infancy of her compeers, as regarded their suitability for public traffic, she stood pre-eminent as the boldest step in mechanical construction ever concentrated in one single effort, and marked an era potent with the most sanguine results, as a point from which other improvements were rapidly starting. Holding, as she then did, the foremost rank in locomotives, we might be allowed, perhaps, to classify these improvements. There were six wheels, all coupled, yielding an increase of adhesion of paramount importance in every state of the weather. Then a vast increase of evaporative power of the boiler, by a new description of heating surface, as well as the never-to-be-forgotten blast or draught pipe, first brought to bear upon this engine, which enabled her to work effectually at 9 miles per hour for 20 miles, with a load of 24 chaldron waggons, at an economy rarely exceeded yet, notwithstanding the successive gradations through which the system has passed since this engine, on the Stockton and Darlington Railway, first led the way. From this display of locomotive talent, he advanced into the contending ranks of the competitors for the £500 premium offered by the Liverpool and Manchester Railway Company in 1829.

The character which he sustained in this competition rests on the merits of his production, the after-display of the adaptation of this engine to the regular traffic conveyance of the line, and the well-attested celebrity of her working long after "Ichabod" had been written over the memory of her rivals. After the full particulars of this trial, and the constructive arrangement of the engine, which were given in our earlier paper, it will be unnecessary to recapitulate them here. Whilst engaged in this competition, a circumstance occurred which we think deserves to be chronicled. Some part of the machinery belonging to the "Novelty," Messrs. Braithwaite & Ericson's engine, having been broken in her transit to Rainhill, the makers were placed in rather an awkward predicament, as she could not be put on her trial until it was mended. Mr. Hackworth being made aware of this, generously offered to repair it for them. He took the broken piece of machinery, welded it, and put it to its lines with his own hands, whilst those gentlemen stood amazed at this remarkable exhibition of friendly feeling on the part of a rival.

Mr. Hackworth was now occupying a prominent line of engineering distinction. The spirited accomplishment of his locomotive undertakings, deserves the highest encomiums; and the successful improvements and modifications of locomotives on the Stockton and Darlington Railway, the economy and efficiency of which, whereby this line rapidly arose from an anomalous existence to a regularly-organised and well-ordered system, and its success as a trial line, is undoubtedly attributable, in no small degree, to the indomitable energy and constructive skill of this distinguished engineer. The Stockton and Darlington Railway was the nucleus of the railway system. She laid bare those wonderful truths with regard to its efficiency, which subdued the prejudices of its stoutest opponents. It was after the proof positive derived from the successful experiments developed here, that the Liverpool and Manchester Railway Company determined on their mode of transit; in support of which Mr. Hackworth gave evidence, through Mr. Robert Stephenson, to the directors whilst deliberating on the course to pursue.

He never could be induced to advocate stationary engines for regular public traffic. With the prescience of genius he foretold the universality of locomotive application, and remained its steady friend and supporter.

In January, 1829, an advertisement was issued by the Stockton and Darlington Railway Company to engineers, offering premiums of 150 and 75 guineas for the best and second best plans, sections, and estimates, for the staiths, machinery, &c., for shipping the coals at Middlesborough. In this Mr. Hackworth became a competitor, and obtained the premium of 150 guineas awarded by the Company, and prepared working plans and specifications, agreeable to his own design, for the whole of the apparatus.

To him we owe the introduction of the crank-shaft for locomotive purposes; also, the single lever-reversing motion, the short-stroked pump, and many and various forms of heating surfaces for locomotives.

In 1834, he took the Company's engine-works at Shildon, contracted for the haulage on the line, and began to manufacture for the public. The fame which he attained for the superiority of his manufacture, only had a parallel in the skill displayed in the constructive details, and adaptation to the various purposes for which they were required.

His professional services were in great repute throughout the neighbourhood, and the collieries which were opening in the district were largely indebted to his engineering skill, for his numerous improvements in winding-engines and general mining machinery—amongst which was the application of the ordinary slide-valve, with its simple gearing, to powerful high-pressure engines, by the use of a relieving piston on the back of the slide for counteracting the steam pressure.

The simplicity of the ram-engine is also worthy of note, the piston having a metal tube cast upon it at one end, which, working through a gland, formed the piston-rod; the tube being large enough to allow of the vibration of the connecting-rod, it was hinged on a pin passing through the centre of the piston transversely, thus forming a direct action to the crank, without the intervention of a parallel motion, or crosshead. Another novelty in locomotive mechanism, which was first introduced in 1837, was the lever-action, or the working a long crank with a short stroke in the cylinder. The utility of this principle was demonstrated in the first engine, and has been confirmed by subsequent experiments. Of this principle he was a warm advocate, and continued to descant on its efficiency as long as he lived, giving it as his opinion, that it would ultimately take the lead, and be proved to be the best adapted in every respect for reciprocal action.

In 1840, after fifteen years spent in the service of the Railway Company, he removed to an establishment of his own, at Soho Works, Shildon. Here, with undiminished ardour, he pursued his professional career, aiding and stimulating, by his talents, the progress of mechanical science.

To the rotatory engine he devoted a large share of study, and many were the machines of this kind started by his fruitful fancy, one of which formed the subject of a patent in 1836. He devoted considerable attention to the subject of smelting iron, with the view of economizing the process, but his ideas were never practically worked out, owing to the pressure of more immediate engagements.

It is not alone as a distinguished mechanical student that we must contemplate Mr. Hackworth, but also as a Christian and philanthropist, which he sustained in a most exalted degree. To a naturally fervent and benevolent disposition, he added the adornment of Christianity and love. Widely apart from the merely superficial, with him it was a reality, and shone conspicuously in daily life. Distinguished by a disposition peculiarly attractive, he won the esteem and regard of all with whom he became associated. He possessed a sympathy of soul which connected him with many of those noble institutions tending to mitigate the misery, and advance the moral and physical condition, of our race; and his influence was extensively felt in those praiseworthy efforts to propagate a knowledge of that Christianity, essential to the everlasting wellbeing of our common humanity.

In the year 1810 he became a member of the Wesleyan Society, with which he held honourable connection as a local preacher and class-leader until the period of his death. Naturally endowed with great moral courage and fortitude of mind, he possessed a fluency and happiness of expression, with a thread of delicate humour and anecdote pervading his discourses, which charmed all who listened to his artless eloquence, issuing directly from the heart, that will long be perpetuated with interesting remembrance.

The spread of divine truth in distant lands shared alike the liberality of his soul and his purse; yet of him it was aptly true, that "the right hand knew not what the left hand did." He avoided popularity, which had no fascination for him; he loved retirement, and preferred the joys of private life to worldly honours, which caused him, though a public character, not to be so universally known. As a man, a friend, and a Christian, his name will live enthroned in the noblest sympathies of our nature. Possessing great natural abilities, kind, compassionate, affable, and sympathizing; that exalted moral worth which alone belongs to the nobility of humanity, adorned in a remarkable degree his character and conduct—which, combined with great frankness, urbanity, and simplicity of deportment, made him to be esteemed and loved by all who thoroughly knew him. By his workmen he was revered, respected, and loved.

His life was characterised by the accomplishment of great moral and physical results, the extension of mechanical science, and the alleviation of the distress of suffering humanity, as well as the formation of undying friendships which will bloom beyond the grave. Constitutionally healthy and robust, his life was one of great activity, both mentally and physically. Every moment was pressed into service, either professionally or in the performance of some good work, which was continued until within a few days of his death. His affliction was but of short duration, during which the greatest resignation, patience, and consideration for those around him, were very conspicuous.

On Friday morning, 28th June, he complained of being unwell, and retired to his room. He grew rapidly worse, and at ten o'clock, p.m., 7th July, 1850, was numbered with the dead.

The multitude of people which assembled spontaneously at his funeral, may be regarded as a striking testimony of that affectionate esteem with which he was regarded by all classes of the community.

Such was the end of that mortality, the existence of which has been marked by the accomplishment of great results by its energy and application, which had nobly fought its course upwards, conquered difficulties, subdued prejudices, and become associated with one of the greatest mechanical achievements of modern times, that has rendered him famous as the father of locomotives.

Our engraving is from a slight water-colour portrait, of no pretensions as an example of art, but acknowledged by his family as a close resemblance of the original. We give it here,

In Memory of

Timothy Hackworth.

EXHIBITION AT THE SOCIETY OF ARTS OF ARTICLES PATENTED OR REGISTERED SINCE THE BEGINNING OF 1849.

We recently visited this "Exhibition of Industry" on a small scale, at the rooms of the Society, in John Street. After procuring a catalogue from the janitor (a goodly-sized catalogue it is, too), we proceeded at once to the large room on the ground floor of the building, and were

almost bewildered with the profusion of models that met our gaze on entering. There appeared to be everything, from the roasting-jack of everyday life, to the curious mechanism and scientific principles of the electro-magnetic clock! The roasting apparatus struck us as being a very useful invention. It consists of two highly polished tin-plates, slightly dished, suspended, one above, the other below, the meat—so as to reflect the heat both from the top and bottom, thereby allowing those parts of the meat to be done equally as well as the sides. Above the top plate is fixed a small cup with a perforated bottom, and below the bottom plate is placed another cup for receiving the fat as it falls from the meat, and as this cup fills it is poured into the top cup, and the fat then gradually percolates through the perforations, keeping a constant stream over the meat. This ingenious and useful article is the invention of Ann Remington, of 11 Shaftesbury Crescent, Pimlico. The next object that took our fancy was a beautifully executed model of Bodmer's Torsional Door-Spring, recently described and illustrated in our pages.* We next came across an object which appeared, at first sight, to be a rudely constructed piano, but, on closer inspection, we found it to be a "Reader for Jacquard Looms," the invention of Duncan Mackenzie, of London. It consists of a series of punches, acted upon by keys in a manner somewhat similar to that of the piano action. The claims of this invention may be seen at page 279, Vol. I., of this *Journal*. There was a very large show of meters—gas and water—but as our visit was a cursory one, we had not time to inspect them minutely.

On one side of the room is a very handsome electro-magnetic striking clock, having its bell and pendulum in two different parts of the building—something novel in horology, and apt to astonish and confound the steady-going Dutch clockmakers of bygone days. We were much pleased with an ingenious model of a submerged feathering paddle-wheel, the feathering action being produced by the axes of the blades passing over a vertical eccentric: this makes a very pretty model, though, we fear, hardly practicable. Stench-trap, by Messrs. Cort & Bell, Leicester: this is a very simple contrivance, consisting of an inverted cup for the cover of the trap, which cup rests with its edges submerged, thus forming an efficient air-tight joint, but allowing the sewerage to pass off freely. The sanatory section contained a goodly array of articles of this class,—a very gratifying sight, seeing that the use or disuse of these simple contrivances influences, in a great measure, the sanatory condition of a town. By this time we have gradually worked ourselves round the room, and are close to the door again, but cannot depart without bestowing a little attention to a large but portable hand grinding-mill for emigrants, the invention of Messrs. Huxham & Brown, of Exeter. It is worked by a lever, alternately pulled and pushed, something after the motion of rowing a boat, and is furnished with apparatus for separating the flour from the bran: a most useful article for emigrants. In the room upstairs we remarked a great variety of razor-guards, the great feature of which appeared to be the intense ingenuity displayed by each inventor to prevent confliction with his neighbour.† We heard Mr. C. Dawson's Autophon—previously noticed in our pages‡—play several tunes, including some plain chants, which were pretty well done; though, of the two instruments, we prefer the barrel-organ. In this arrangement, the rushing of the air through the holes in the "cards" makes a very disagreeable accompaniment to a slow psalm tune.

With our two hours' ramble—by no means an unprofitable one—we quit this collection of ingenuities, with the hope of seeing a still more advanced show in 1852.

PATENT LAW REFORM.

PROGRESS OF THE MOVEMENT.

Since the appearance of the article on Patent Law Reform, in our last month's *Journal*, the subject seems to have very much increased its share of public attention. The committee of the Society of Arts, alluded to last month, have issued their first report upon the subject, and this we now propose to consider.

This report contains much useful and practical information, but does not, in all cases, tell the strict truth. We should have thought the real facts would have appeared quite sufficient to damn the present system, without having recourse to the distortion of circumstances, which, in many cases, is evident in the pamphlet before us.

After stating some of the circumstances which created our present Law of Patents, the report goes on to say—"It must clearly be borne in mind, that no inventor, or discoverer, or proprietor, of any invention, is in any position to claim any right whatever, until he has passed through all the following thirty-five official stages of cost and delay." Then comes a tabular statement of the fees payable upon the grant of an unopposed English patent, which we give with an additional column of our own, showing the precise amount of fees payable, and, more concisely, the actual offices through which English patents are passed. The first column is our addition, and columns two and three, those given in the report:—

1. Petition and Declaration, 1s. 6d.	1st. Inventor prepares humble petition to the Crown,		
	2d. Which he must fortify by a declaration taken before a Master in Chancery, and pay		£0 1 6
2. (Home Office) Reference, £2. 2s. 6d.	3d. He delivers petition and declaration to the Home Office in Whitehall, and pays		
	4th. Home Secretary signs petition after some days, and refers it to Attorney or Solicitor-General.		2 2 6
3. Attorney-General's Report, £4. 4s.	5th. Petition taken to the Attorney or Solicitor-General, at their chambers, and the fees paid to them and clerks are		
	6th. Attorney or Solicitor-General reports in favour of petition, as a matter of course, unless opposed.		4 4 0
4. Queen's Warrant (Home Office), £7. 13s. 6d.	7th. Report taken back to the Home Office in Whitehall.		
	8th. Home Office prepares a warrant, which echoes the report, and is		
	9th. Sent to the Queen to sign.		
	10th. Returned to Home Office, and		
	11th. Home Secretary countersigns warrant, and the fees paid are		7 13 6
5. Patent Bill, £15. 16s.	12th. Warrant taken to Patent Office in Lincoln's Inn.		
	13th. Clerk of the Patents prepares a draft of the Queen's bill, and docquet of the bill, and the fees paid are		5 10 6
	14th. And engrosses two copies of bill, one for the Signet Office, and one for the Privy Seal Office, fees,		1 7 6
	15th. Stamp duty on each,		6 0 0
	16th. Engrossing Clerk of the Patent Office engrosses Queen's bill for signature, fees,		1 1 0
	17th. Stamp for same,		1 10 0
	18th. Queen's bill taken to Attorney-General or Solicitor-General, and signed by them, fees,		6 0 0
			£21 9 0
6. (Home Office) Queen's Bill, £7. 13s. 6d.	19th. Taken back to Home Secretary.		
	20th. Sent by Home Secretary to the Queen.		
	21st. Signed by the Queen.		
	22d. Returned to Home Secretary, and fees paid are,		7 13 6
7. Signet Bill, £1. 7s.	23d. Queen's bill taken to Signet Office.		
	24th. Clerk of the Signet prepares a Signet bill for the Lord Keeper of the Privy Seal, and the fees paid are,		4 7 0
8. Privy Seal Bill, £4. 2s.	25th. Clerk of the Lord Keeper of the Privy Seal prepares a Privy Seal bill for the Lord Chancellor, and stamps, fees paid are,		4 2 0
9. Great Seal, £49. 6s.	26th. Privy Seal bill delivered to the Clerk of the Patents.		
	27th. Clerk of the Patents engrosses the patent, and fees paid are,		5 17 8
	Stamps for the patent, &c.		30 0 0
	28th. Clerk of the Patents prepares a doquet thereof.		
	29th. Stamp for the doquet of patent,		
	30th. Boxes for the patent,		0 9 6
	31st. Fees to the deputy(?) the Lord Chancellor's purse-bearer.		2 2 0
	32d. Fees to the Clerk of the Hanaper,		7 13 0
	33d. Fees to the Deputy-clerk of the Hanaper,		0 10 0
	34th. Recipe of the Lord Chancellor for the Privy Seal bill, which he signs,		1 11 6
	35th. Fees to the Deputy-sealer and Deputy-chaff Wax,		0 10 6
£95 6 0			£48 14 2
			* £99 7 2

From this statement it appears that the committee have made an error of £4. 1s. 2d. in stating the total official fees on obtaining English patents.

The report then gives a statement of the method of passing English patents, but as we have already given this at page 129 of our second volume, it is not necessary to repeat it here.

With reference to the proceedings in the cases of opposed patents, it is said, "This investigation is stated to be a very unsatisfactory proceeding;" and again, after enumerating some evidence upon the subject, the report states, "Moreover, this investigation is the source of fraud." To enable our readers to understand the remarks that follow, we are compelled to reiterate the form of the proceedings in these cases.

On the petition for letters patent coming into the office of the attorney or solicitor-general, his clerk issues to all those parties having caveats in the office, which appear to refer to the title before him, a notice that A. B. of C. D. is applying for a patent for improvements in (steam-

* Page 107, Vol. III.

† One of these, ycleped the "Plantagenet," we have figured and described at p. 9, Vol. II.

‡ Page 221, Vol. II.

* We make this amount £100. 7s. 2d., so that the error is really £5. 1s. 2d. We have strong suspicions of the purity of the Society of Arts' arithmetic.—Ed. P. M Journal.

engines), and that, unless an opposition is entered with him within seven days from that date, the patent will proceed. Upon this, the party having entered the caveat, if at all apprehensive that the applicant has an invention of a similar nature to his own, enters, with the clerk of the attorney-general, a note of his intention to oppose the grant; when the applicant obtains from the attorney-general's clerk, an appointment for a hearing of the case, and a summons apprising the opposing party of it, and naming the day and hour upon which the attorney-general will hear the parties. On the day appointed, the applicant and his opponent attend the attorney-general, and are heard separately, the petitioner stating (in private) to the attorney-general, the general description of the invention for which he is applying for letters patent; and the opponent, afterwards (also in private), giving the grounds of his opposition. The attorney-general then, having the particulars of both inventions before him, decides as to whether there is any confliction between them or not. If the inventions conflict, then the parties must take out a joint patent, or the applicant will, in some cases, to avoid any difficulty, strike out of his particulars any portion which his adversary may also have.

This is the investigation which the Society of Arts committee gravely state to be a farce, and "often the ground of fraud." If they had been assisted in their investigations by any gentleman practically conversant with the mode of passing patents, he would in all probability have told them, that of all the steps necessary to be gone through, the proceedings before the attorney or solicitor-general are the least objectionable.

It has been urged, that a lawyer is not sufficiently conversant with science, to enable him to decide in such cases; but we are convinced that no tribunal to be appointed for such a purpose—and that there must be such a stage cannot be denied—would be more likely to give general satisfaction than the decisions of the attorney and solicitor-general. The patience and painstaking attention of the present attorney-general, Sir John Romilly, in this task, are well known, and cannot be too highly spoken of.

We will now say something of the probability of this investigation being a source of fraud, as broadly stated in the report, and as still more coarsely alluded to in two leading articles which have lately appeared in the *Times* on the subject. From what we have before stated, our readers will easily imagine that it must require a large amount of ingenuity to enable what are called the "Patent Jobbers," who, we are informed, are a body of men who have entered caveats with the attorney and solicitor-general, for the purpose of giving themselves an opportunity of opposing any inventions coming into those offices, for the reports, that appear likely, from the scientific standing of the inventions, or otherwise, to be of great value—to fish out the particulars of such inventions. As we have had considerable experience, both in the conduct of oppositions, and in the passing the applicants' petitions and obtaining their reports, we can safely affirm, that it must be from great laxity on the part of the inventor himself, if he allows the opposing party to obtain any particulars whatever of his invention by this proceeding, and certainly not through the connivance, or "loose method of proceedings," as stated in the *Times*, of the attorney or solicitor-general, or their subordinates.

Upon the next subject alluded to in the report before us, the enrolment of specifications, and the trouble consequent upon making searches, to ascertain the novelty of inventions, we cordially agree in their remarks. Prior to January 1, 1849, specifications were enrolled in three distinct offices; and in very many cases, on searching for a particular specification, all these offices must be visited, and fees paid in each, before the specification can be seen; and then, in two of the offices, no extracts are allowed to be made by the inspector, nor is he allowed to have any particular portion of the specification copied by the officials; but if he requires merely a short extract, he is required to take what is called an "office copy" of the whole deed, with the drawings, at a rate fixed by the office, and which is exorbitantly high. The order by which all specifications are compelled to be enrolled in one office—the Chancery Enrolment Office—was a great advance in favour of inventors, as, in searching for recent specifications, one office only has now to be visited; but the arrangements respecting extracts still remain the same.

The time occupied in procuring the grant of letters patent for England, is stated to average two months; this is a very unusual period. In an unopposed case, the time averages from four to five weeks; and if there is an opposition, this period is extended from a week to ten days.

After some observations upon the cost of litigation in patent matters, and also on the effect of the "Utility" Registration Act, the report winds up by stating that the committee have affirmed the following resolutions:—

"That registration of inventions should be obtainable for a period of one year, on payment of £5, and should be renewable for four periods of five years, on payment of £10 at the first renewal; of £20 at the second renewal; of 50 at the third renewal; and of £100 at the fourth renewal.

"That the surplus profits, after paying office expenses and compensation, should be directly applied to some public purposes connected with invention, but not carried to the consolidated fund.

"That there should be penalties for using the titles of patents or registrations where none existed."

Without offering any remarks upon this scheme, which, it appears to us, would be very objectionable in practice, we will lay before our readers another proposition, submitted by "a gentleman who is extensively engaged as counsel in the administration of the present law of patents," to the editor of the *Times*, and which appeared in that paper on the 14th of December:—

"The cost of letters patent for the United Kingdom, in opposed cases, not to exceed £130, and to be divided as follows:—England, £70; additional for Scotland, £30; Ireland, £20; colonies, £10—total, £130.

"The charges up to, and inclusive of the warrant, to be charged for the United Kingdom—that is, they are to be paid though letters patent for only one country be sealed; this constant amount may be taken at, say, £30; so that a patent for Scotland alone would cost, say, £60; for Ireland, say, £50; and for the colonies alone, say, £40.

"No extra fees for several names. No expedition fees.

"The payments to be as follows:—

"General Charges for the United Kingdom:—		
"1. On application at Home Office,		£10
"2. On reference at Patent Office,		10
"3. For the warrant at Home Office,		10
		30
"Special for England:—		
"4. At Great Seal Office,	£10	
Stamp,	30	40
"Total,		70
"Special for Colonies:—		
"At Seal,	£5	
"Stamp,	5	10
"Special for Scotland:—		
"At Seal,	£10	
"Stamp,	20	30
"Special for Ireland:—		
"At Seal,	£10	
"Stamp,	10	20
"Total,		£130"

The *Times* criticises this scheme as not being comprehensive enough for the present emergency, but we cannot but agree with its proposer in the general scope of the plan. We are, as we have stated before, averse to the system of granting patents for next to nothing, and think it is a very fair source of revenue. There are many suggestions which might be made upon the system last proposed, but having laid these several statements and propositions before our readers, we shall leave the subject, until another month gives us a further opportunity of discussing them, along with any other matter which may arise prior to our next publication. In the meantime, we may state that it will give us pleasure to make these pages the means of disseminating the ideas of any of our practical readers upon this highly important subject.

REMOND'S ENVELOPE MACHINERY.

We are always happy to notice the favourable progress of any mechanism delineated in our pages, and as we were present a few days ago at the establishment of Messrs. Waterlow, the extensive wholesale stationers in London Wall, to witness the performance of one of M. Rémond's machines on trial at that establishment, we propose to give some notes on the alterations in its method of working since the date of our former article. The beautiful simplicity of this machine reflects the highest praise upon its inventor. We had a favourable opportunity of contrasting its performance with the effects of manual labour, the room in which the machine was at work being also occupied by a number of girls busied in the process of envelope-making by hand.

The principal features in the new modification of this ingenious piece of mechanism, are, in the first place, the substitution of a pair of bellows for the air-pump marked F, in our engraving given at page 169 of our second volume, for the purpose of inclining in the edges of the envelope, previous to the second descent of the plunger, *g*. These bellows, standing vertically immediately under the folding-table, give the machine a far more compact appearance than in the old arrangement; they are worked directly from the shaft, A, by means of a cam fitted for that purpose above. The bellows, K, also stand vertically. The moveable table, Y, for holding the envelope blanks, receives its vertical motion by a much

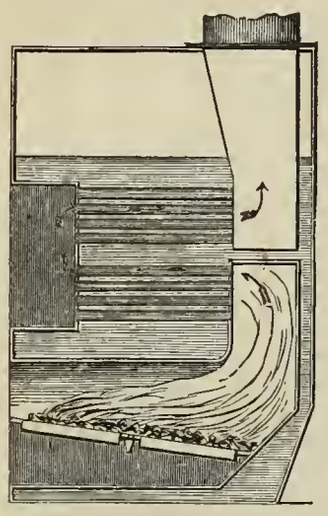
neater contrivance than formerly shown, being simply a rocking-shaft with a small arm, which catches in a slot cut in the vertical pillar, or support of the table, Y. We observed also that the air passages, *o*, round the edge of the folding-box, are now placed with their mouths on its surface, and not on the inside. This appears to be a considerable improvement, as by this means, what is vulgarly termed a "sucking" action is obtained, while the blank is lying flat on the box, previous to the first descent of the plunger, thereby holding it firm in its place. We also noticed a very ingenious contrivance for inking the embosser, in case a coloured design is required; it consists of two small inking rollers attached to the ends of a radiating arm, worked by a cam on the shaft; they are made to pass over the face of the die immediately before the descent of the stamper. In the experiments made during our visit, this machine threw out, on an average, 60 envelopes per minute, and showed a capability of being worked at a much greater speed. The improvement in the general appearance of this machine is particularly commendable; the framework being lightened, and the design improved very materially. It reflects great credit on the makers, Messrs. Sharp of Manchester.

RECENT PATENTS.

TUBULAR BOILER.

W. Pim, Esq., *Kingston-upon-Hull, Engineer.—Enrolled Jan.* 3, 1850.

The great superiority of the marine tubular boiler, compared with the old flue boiler, scarcely needs insisting upon here; but the acknowledged advantages of compactness and lightness are somewhat diminished by the fact of the rapidity with which the flame passes off into the chimney.



A great amount of the heat which ought to be absorbed by the water is thus lost, and hence arises the complaint of the steamboat proprietor, of the enormous consumption of fuel. Mr. Pim has attempted to remedy the defect we have mentioned, by the introduction of the boiler, of which we give a vertical section. The plan consists in giving a double circulation to the flame and heated gases through the tubes, so as to keep the heat longer in contact with the surfaces communicating with the water. This double circulation is secured by a water space, which divides the set of tubes into two tiers, the flame being stopped by the water space, and turned to pass through the tubes in the lower tier, after which it returns through the tubes above, and passes to the chimney, thus doubling the circuit of the traversing heat.

The "Helena Sloman," an auxiliary-powered steamer of 800 tons, and 160 horse power, built for the Hamburg and New York station, is fitted with these boilers. Their success in this example is complete. The vessel has performed her outward and homeward voyages in twenty and eighteen days respectively.

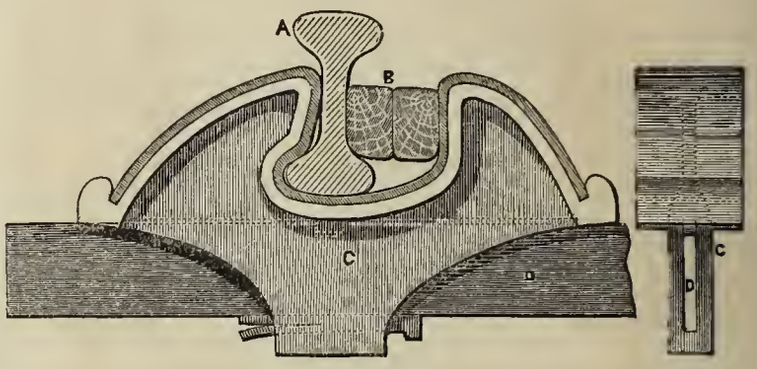
PERMANENT WAY OF RAILWAYS, AND ROLLING IRON.

J. W. Hoby, *Blackheath, Kent.—Enrolled Dec.* 21, 1850.

The subject of permanent way has latterly attracted much attention, from the rapid destruction and deterioration of rails and sleepers; and various patents have been taken out for improvements, and the construction of the various parts, so as to insure more steadiness to the road, and more durability to the parts themselves. Amongst these may be noticed that of Mr. Peter Barlow, for a cast-iron support to the rail, composed of two or three chairs cast on the same longitudinal bearer, secured by keys in the usual manner, or made in two halves, and bolted underneath the rail; that of Mr. W. H. Barlow, consisting of a rail rolled, with a wide base forming its own bed on the ballast, and secured by cast or wrought-iron joint-pieces at the abutting ends of the rails; and that of Mr. Samuel, which comprises a mode of "fishing" the joint of the rail, by means of two flitches—one on each side—with four bolts securing the whole; also, a mode of securing the rail in a cast or wrought-iron longitudinal trough sleeper, by means of wood flitches, one on each side of the rails, or by bolts and nuts passing through the web of the rail, and securing a wrought-iron flitch against one side of it, and, at the same time, holding the rail up against the side of the bearer on the other.

All these have their advantages. The mode which Mr. Hoby has adopted in the improvements he suggests and claims, relate principally to the construction of a longitudinal wrought or cast-iron bearer, fitting the rail on one side, and secured to it on the other, by means of keys. These keys differ from those in ordinary use, by being made each in two

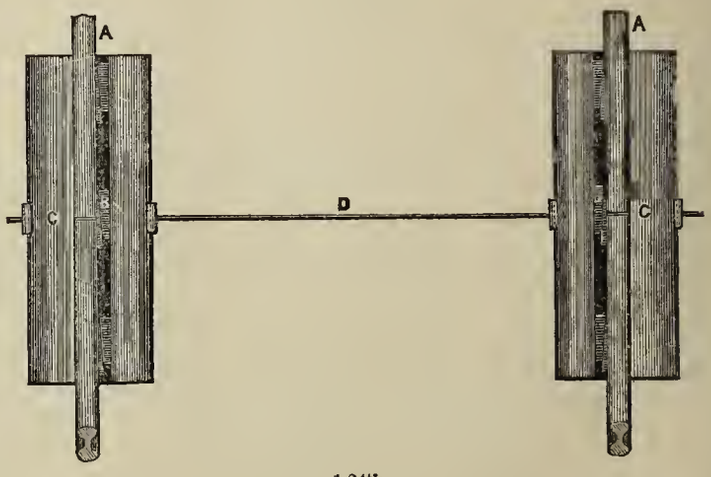
Fig. 1. Fig. 2.



1-4th.

pieces, with a reverse taper, so as to form a "folding" key, or wedge. The bearer has the advantage of supporting the rail continuously throughout its own length; and any number may be used, so as to make the intervals between them greater or less, and afford more or less support to the rail, as may be necessary—whilst the folding-keys admit

Fig. 3.

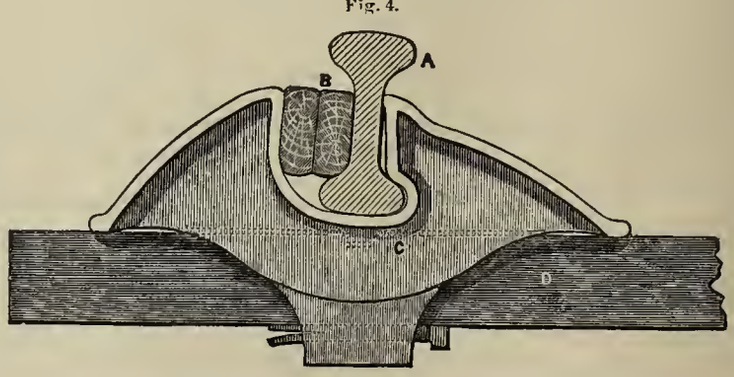


1-24th.

of being readily driven, fit the rail and bearer throughout their length, and allow for being tightened up when they shrink. They are also applicable to the existing chairs.

In the sketches, fig. 1 represents a cross section of a wrought-iron

Fig. 4.

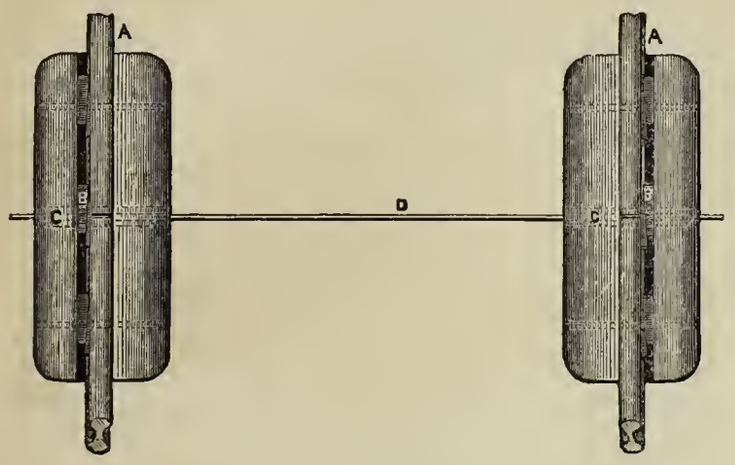


1-4th.

bearer. A, Is the rail, and B, the folding-key. The part C, is a cast-iron piece, with a stirrup, or recess, cast through it, which holds the wrought-iron bearer, and receives in the stirrup a wrought-iron cross-bar, D, set on edge, for the purpose of securing the guage and the tilt of the rails. Fig. 2 is a side elevation of the parts, without the rail; and fig. 3 is a plan showing two sleepers and the cross-tie complete.

Fig. 4 shows a section, and fig. 5 a plan, of sleepers, of similar construction, made of cast-iron; the same letters indicate the same parts, but the stirrup, C, is cast with the sleeper.

Fig. 5.



1-24th.

The cost of such a road per mile of double way, exclusive of rails, would, at present prices, be about £1,100—the cost of a good road, laid on the ordinary construction, with transverse sleepers, chairs, pins, &c., may be taken from £1,400 to £1,550 per mile of double way, exclusive of rails; and the construction above described would be of cheap maintenance, the number of parts being reduced, and the rails secured at the joint into the longitudinal bearer, so as to avoid shaking or displacement.

The cost of the road, with wrought-iron bearers, would be somewhat more approaching £1,400 per mile of double way—if laid, as the patentee recommends, with folding-keys made of cast-iron, coated with tar, or driven with thin sheet-lead.

The patentee describes several different modes of applying these bearers and folding-keys, adapted to bridge rails and flat-bottomed rails, and to a rail of a new section, which he believes will be found more economical, both in itself and to the rolling stock, than any hitherto used; and he also describes a wrought-iron transverse bearer, which would further simplify the construction of the permanent way.

Another point of improvement, specified under this patent, is a plan of rolling iron into shapes suitable for this system of bearers, and forms of a similar nature.

We have not, at present, time to do more than detail thus briefly the subject-matter of Mr. Hoby's improvements. The new system appears to possess claims for great substantiality, and we shall watch its behaviour under its practical application.

APPARATUS FOR CHANGING THE POSITION OF CARRIAGES ON RAILWAYS.

Messrs. Ormerod & Shepherd, *Manchester.—Enrolled August* 7, 1850.

The points of superiority claimed for this apparatus are, that the carriage may, in its removal, be received, sustained during its traverse, and discharged, by means of one and the same pair of rails, laid continuously, or without break, on an oscillating frame; thus the transfer may be effected from one line to another, without in any way affecting the permanency of the rails. We have a set of the drawings before us, but our limits prevent us from reproducing so extensive a series as wood engravings. In the absence of these illustrations, we may briefly describe the very ingenious movement which has been adopted.

A pair of transverse rails are fixed above the line of permanent way, at such a level as to allow the flanges of the four wheels of the shifting truck to clear the rails beneath. This truck is simply a rectangular cast-iron frame, carrying a transverse shaft, or axis, to the ends of which are secured the two sides of an oscillating frame. The two longitudinal side pieces of this frame are sloped away in each direction from the centre, so as to form a duplex incline. To the sides of this frame are attached another pair of rails, parallel with the main line; and upon these rails it is that the carriage is supported, whilst it is removed from one line of rails to another. Either end of the oscillating frame may be elevated, by means of a couple of pairs of wedges acting upon the transverse connecting pieces, or ends of the frame; and through the medium of two levers, at opposite ends, the end required is elevated. This movement, of course, causes a depression of the opposite end, the rails upon which, being sloped away beneath, rest upon the line of permanent rails, and thus form, as it were, a continuation of the main line. The carriage is then run upon these rails, and the oscillating frame is brought to a horizontal position by its elevating wedges. The truck and its load are then removed along the transverse rails to the required distance, and the carriage is allowed to descend by letting down the proper end of the oscillating frame.

In another modification of this plan, the oscillating frame is supported on two axes. When a carriage is to be run upon the truck, the end of the latter, opposite to that upon which the carriage is received, is raised, so as to depress the ends of the rails attached to the oscillating frame, and cause them to rest upon the permanent rails. The carriage being lowered, the oscillating frame will assume the horizontal position for traversing, resting upon the two axes. The carriage may then descend from the truck as required.

REGISTERED DESIGNS.

TUBE FOR COLONEL HAWKER'S NEW IGNITION FOR GUNS.

Registered for Alfred Clayton, *Gunmaker, Lymington, Hants.*

The object of this little contrivance is to give the detonating tube a firmer hold of the anvil, and to enable it to be handled with greater ease. Fig. 1 of our engravings is a plan of the upper side of the improved tube; fig. 2 is a corresponding edge view, or elevation at right angles to fig. 1; fig. 3 is a plan of the under side of the tube; and figs. 4 and 5 are top and edge views of it, as applied to the anvil of the gun. A, Is the cylindrical portion of the tube, which is filled with detonating powder; B, is a spring shield or clasp attached to the end of the tube, and by which the tube itself is attached to, and retains its hold upon, the outer end, C, of the anvil, D, until the percussion powder is exploded; at E, is a hole for conveying off any wet which may fall upon the upper surface of the anvil, and so prevent its going into the interior of the barrel of the gun. The modified tube appears to provide a remedy for what every sportsman must have occasionally felt as an inconvenience.

Fig. 1. Fig. 2. Fig. 3.

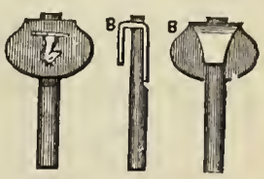


Fig 4

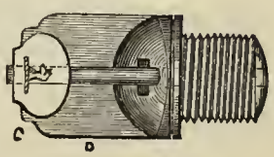


Fig. 5.

SAFETY-PLUG FOR BOATS AND VESSELS.

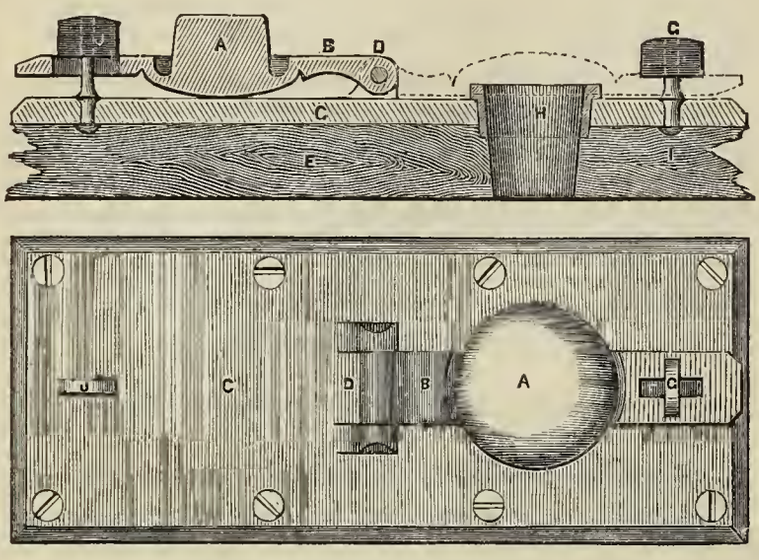
Registered for Thomas Thompson, Esq., *Commander, R.N., Leith.*

The recent fatal steamboat casualties—amongst which, the Clyde ship, "Orion," figures in a most conspicuous manner, in reference to the very point now before us—have at last aroused the attention of practical men to the strong necessity for more particular attention to the safety fittings of boats. The disclosures consequent upon the disasters to which we refer, have shown us, that, not unfrequently, the boats have had few claims to the character of life-preservers. The boring of holes through a boat's bottom, regardless of any provision for closing them in time of need, partakes of everything that is absurd and disgracefully careless; and if the evidence of such gross negligence had not been particularly prominent, it would have been thought ridiculous for belief.

Commander Thompson's plan professes to deprive the most heedless man from sacrificing life in this way, for it provides an instant means of shutting up the plug-holes, under any circumstances.

Fig. 1 of the engravings, represents a longitudinal sectional elevation of the "safety-plug," as fitted to the garboard strake in the well of a boat—the plug being open, whilst the dotted lines exhibit it in its closed state. Fig. 2 is a corresponding plan, with the plug closed down. A, Is the conical plug, formed on the underside of the holding-lever, B, which is hinged to the metal plate, C, at D, the plate being fastened down upon the plank, E. The front end of the lever, B, is slotted longitudinally at F, to admit the hasp, G, standing up from the plate, so that, when the plug is shut down, it enters the socket, H, in the plate, and is firmly secured in position, by a tube of the hasp, which is capable of revolving at I, in the plate, to bring the flat top of the hasp across the slot. To

keep the plug open, and down out of the way, a second hasp is fitted at J, in the opposite end of the plate, C, to suit the position of the holding slot, when the lever is thrown back.



This fastener is always at hand, and as it cannot easily be injured, and will utterly prevent leakage, it must secure for itself very extensive adoption. The "Africa" (Cunard's line) steamer's boats, are fitted with it.

OVAL DOUBLE FURNACE FOR STEAM-BOILERS.

Registered for Messrs. J. Fernihough & Sons, *Victoria Boiler Works, Dukinfield.*

The improvements contemplated by Messrs. Fernihough, are the securing an increased heating area, quicker generation of steam, prevention of smoke, and non-liability to accident. From the plans before us, we gather that the modified details are applicable to two different arrangements of boilers. In the first, or "smoke-burning steam-boiler," there is a single oval tube, divided at the furnace end by vertical oval water tubes, so as to form a double furnace, and it is strengthened by a hollow wrought-iron bridge, at which point the two currents from the furnaces meet. Alternate firing is resorted to for the prevention of smoke, so that the unconsumed gases from one side pass through, and are consumed by, the flame of the other. The combined current passes over the top of the bridge, and thence along a contracted flue, to the end of the boiler, returning by side flues to the chimney. Beneath the bridge is a short oval flue, with an adjustable valve-door, by which air may be admitted from the ash-pit, and the central smoke flue cleaned. In the second, or "smoke-burning horizontal tube steam-boiler," there are two distinct furnaces, which unite with five or more round or oval flues, at a belt or contraction, the object being to gain an extended heating surface. As before, the furnaces are fired alternately, and as one fire is always at a red heat, it answers as a consumer of the unburnt gases from the other.

Messrs. Fernihough would appear not to have been aware of the existence of Mr. Fairbairn's patented double furnace boiler, which acts on a principle precisely similar, as far as the "alternate firing" system goes. The original intention of the inventor was simply to enlarge the steam space, and prevent priming. The simple plan of alternate firing was an after-thought. The chief difference between the two arrangements, is in the division spaces and bridge of the furnace. In Mr. Fairbairn's boiler, too, the junction of the two currents was effected, not at the back of the furnace, but at the extreme end of the boiler.

PORTABLE FAMILY MANGLE.

Registered for Messrs. G. H. & G. Nicoll, *Dundee.*

Messrs. Nicoll's invention has for its object the obtainment of increased power in working roller-mangles, whilst the essential feature of simplicity is maintained uninjured, and the mangling effect improved. Our engravings give two views of the machine. Fig. 1 is a front elevation, and fig. 2 a corresponding side view of the mangle complete.

Fig. 1.

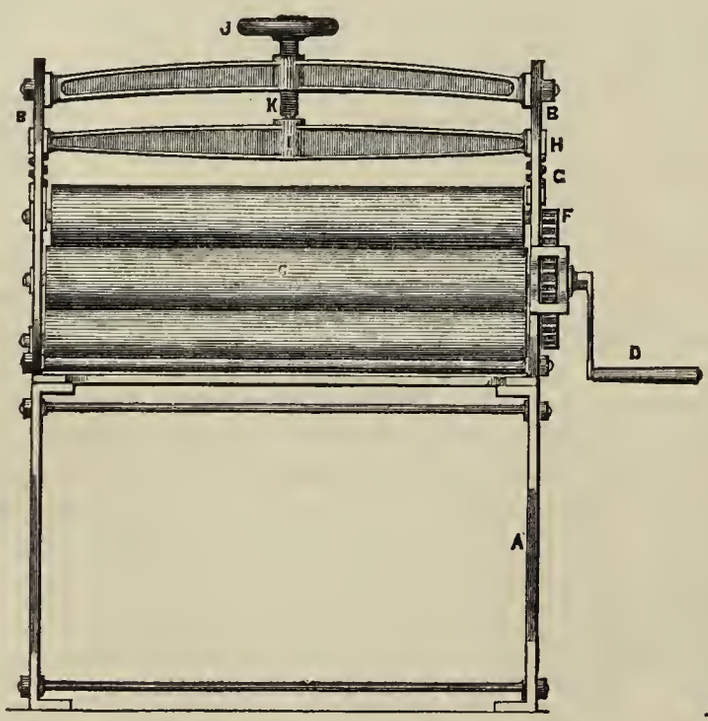
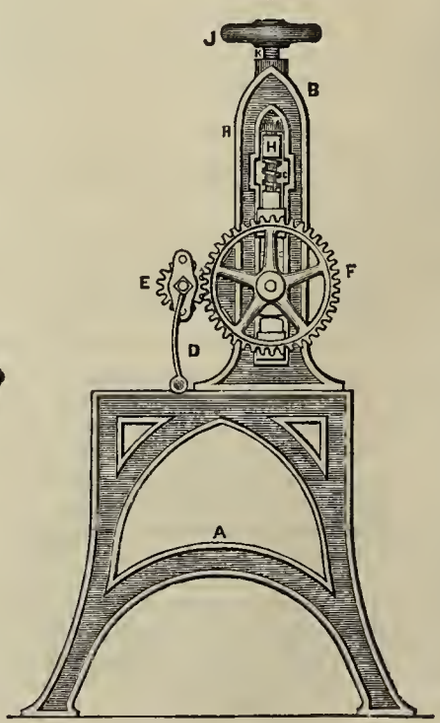


Fig. 2.



The framework consists of two side standards, A A, connected by cross tie-rods, and having bolted upon them a second pair of standards, B B, which are grooved vertically, to receive the bearings of the three rollers, C. These rollers receive motion from the winch-handle, D, the stud of which carries a pinion, E, gearing with the spur-wheel, F, on the shaft of the centre roller. Thus the centre roller is the driver, and actuates the other two by frictional contact. The requisite pressure for mangling is communicated to the rollers by two helical springs, G, passed upon guide spindles, the lower ends of which rest upon the bearings of the upper roller. The upper ends of these spindles are passed through eyes, H, one of which is formed in each end of the cross-bar, I, passing across between the two standards.

At J is a hand-wheel, fast on the top of the screw, K, the lower end of which rests on the top of the cross-bar, so that, by turning the hand-wheel, the action of the two helices may be accurately regulated. The clothes, or other articles to be mangled, are entered upon the rollers, and passed through them, by means of a cloth, in the manner ordinarily adopted in roller mangles. The whole arrangement is extremely neat, and the framing possesses some claims to elegance of design.

The substitution of this class of mangle for the old weighted box rolling apparatus is a very great step in the improvement in the machinery of our domestic operations. The simple combination of a set of rollers answers all the purposes of the original machine in a much superior manner, whilst it is capable of rendering an additional service in squeezing or wringing the moisture from the wet articles. The diminution of the occupied space is another object of some importance in the situations where such apparatus is commonly employed.

CENTRIPETAL WHEEL-PLATE.

Registered for Messrs. W. & C. Middleton, *Carriage-builders, London.*

The wheel-plate of carriages has been the subject of many improvements, and a considerable amount of ingenuity has been expended upon this detail of carriage mechanism. Whilst the framework and movements of a carriage must necessarily be of the most substantial kind, weight must ever be an important point; and the position of the fore and hind wheels, as affecting the draught, cannot be too carefully considered.

The latest, and certainly the most ingenious improvement of the kind is that just introduced by Messrs. Middleton, of Long Acre. In our engravings, fig. 1 exhibits a plan of the movement, as it appears when the carriage is in a perfectly straight position. Fig. 2, again, shows the arrangement as under full lock. The principle of the plan is, that as soon as the carriage comes on the lock, the whole of the fore carriage works forward independent of the body, and is never by any chance thrown out of the centre, as occurs in all previous arrangements. A and B are the upper and lower bed plates, C are the futchells, and D the hind felloe-piece. The transom plate is at E; it is of a semi-elliptical form, and has a groove, F, cut in it. The egg-shaped wheel-plate is at G, the front portion corresponding in shape to the transom plate. The bar, H, forms the conjugate axis of the wheel-plate; it is slotted longitudinally, to receive the sliding centre-bolt, I. A pin is attached to the end of the bar, K, and this pin projects into the groove, F. The carriage is thus considerably shortened between the front and hind wheels.

Fig. 1.

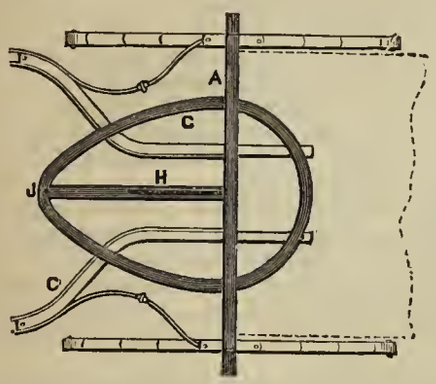
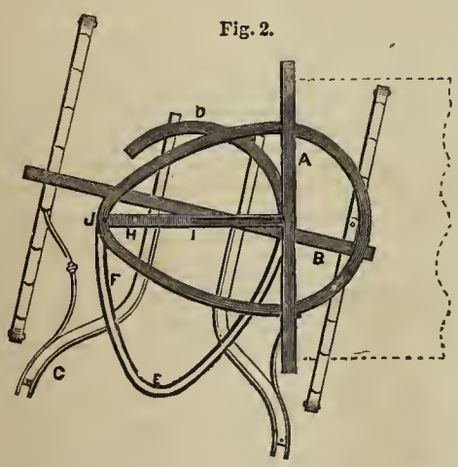


Fig. 2.



The great superiority of this contrivance, in providing for the carriage, being perfectly central when on the full lock, cannot be too clearly explained, as the movement thus works as easily as the ordinary perch-bolt, whilst its simplicity is unquestionable. The front wheel-plate, being elliptical, has a very light appearance, and it is certainly more symmetrical than the old circular form.

COOKING RANGE.

Registered for Messrs. E. O. & L. Tindall, *Scarborough.*

The introducers of this cooking range have set a spirited example to their neighbour tradesmen, in the production of a great variety of improvements in domestic utensils and household mechanism. Their present example is an excellent arrangement of a cooking fire, with oven and boiler on opposite sides. The flues from both the fire and oven pass through the back, in the same way as in Mr. Suttie's boiler, where the flues are taken advantage of to heat the water in the boiler back;* and the whole range, including the fire, having a flat top—an extended hot plate is thus obtained. The fire bars are all moveable, and there are two bottom grates for the reduction or enlargement of the fire. A brass ventilator is fixed in the top of the oven door, and a steam pipe passes up from the oven top, with a revolving damper, so that a constant current of pure unburnt air is carried through without cooling or stopping the cooking action—carrying off the steam at the same time. The oven flue is a descending one, and contrived to consume its own gaseous products. As a whole, the range is a very creditable specimen of its class.

* See page 89, Vol. II.

FORK FOR WEFT PROTECTOR.

Registered for Mr. H. Booth, *Swinton, Lancashire.*

The weft-fork, as ordinarily made of solid metal, is liable to fracture from several causes. Sometimes the slight prongs or wires come in contact with a trapped shuttle, or with the body of the slay, and occasionally with the wires of the grid. In any of these cases, the chances are that the prongs snap off at the bent portion, or at the shoulder. Although this detail of weaving mechanism presents a comparatively unimportant appearance, yet, in large establishments, the cost of purchasing new forks, and repairing old ones, is by no means inconsiderable.

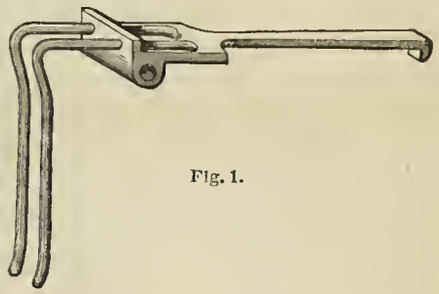


Fig. 1.

Mr. Booth's contrivance affords a cheap and ready means of repair, which will obviate the necessity of the present alternatives of laying aside the fractured forks, or submitting to the insecure mode of repair by soldering. Fig. 1 of our engravings represents a perspective view of a two-pronged fork of the improved kind; fig. 2 is a similar view of one with three prongs; and fig. 3 is a detail, showing the body or holder of the prongs in section. The wires are passed through corresponding holes drilled in the angular projection on the end of the holder, and their ends are bent at right angles, and riveted into a second series of holes drilled through the flat part of the holder behind. If a wire breaks, a new one may be at once inserted, and the fork is made as good as at first.

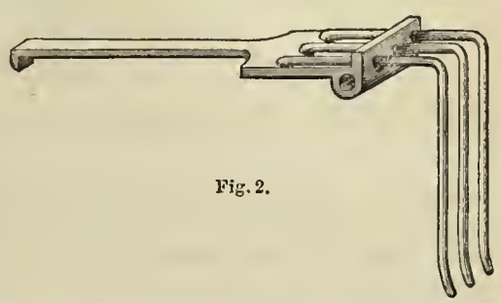


Fig. 2.

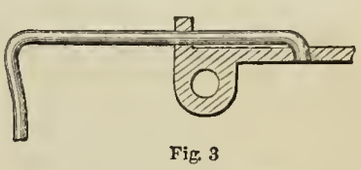
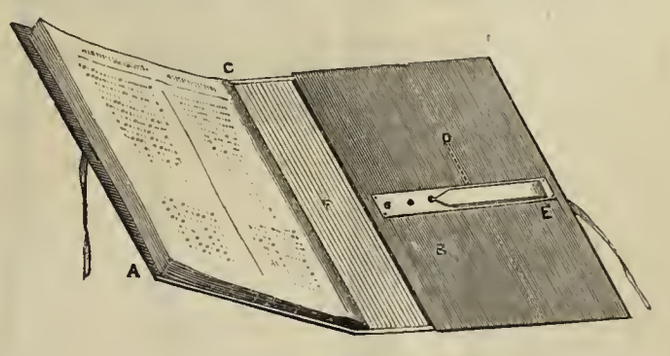


Fig. 3

PAMPHLET-BINDER.

Registered for Mr. J. E. M'Cabe, *London.*

This is decidedly the best of the numerous contrivances of this class which we have seen. Our engraving represents the "holder" as open,



with some numbers of a pamphlet, or sheets of music, placed in it. It consists of two neat cloth-boards, A B, to the former of which is attached a junction-piece of leather at C, answering the office of the leather binding of a book. This junction-piece is passed into the recess between the back and front portions of the double board, B, up which it extends, as indicated by the dotted line, D. A small notch is cut in the inner board at E, and through this a leather strap, attached to the edge of the sliding junction-piece, is passed, and having a book in its extremity, it is capable of being fixed at any point in a piece of brass perforated with a row of small holes. The junction-piece, or central back, has a series of attaching ribands attached at each end, side by side, for holding the papers or sheets. Thus, as each sheet is inserted under its retaining riband, the sliding junction-piece is drawn out further from its recess in the double back, B, and secured from slipping in either direction by the

hooked strap which we have described. Our sketch shows the holder with some sheets laid in it, but sufficiently expanded to receive several more. The invention is simple, easily managed, and answers excellently as a holder, whilst its usefulness is not impaired by any unsightly or inconvenient attachments.

AGRICULTURAL CART.

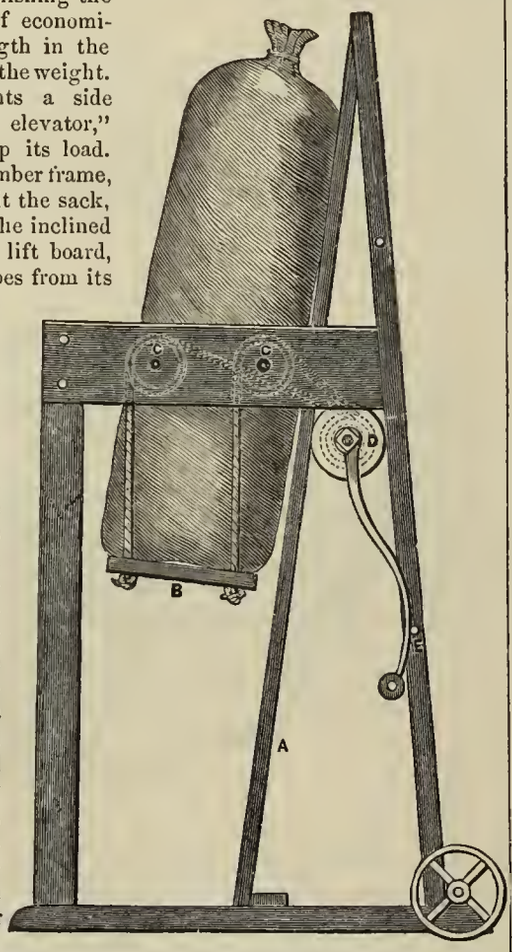
Registered for Messrs. Fowler & Fry, *Bristol.*

The peculiar feature of improvement in Messrs. Fowler & Fry's cart is in the mode of attaching the shafts to the bottom. This is effected by bent wrought-iron plates, so as to dispense with any bending in the wooden shafts themselves. This plan of connection also answers well for the tipping movement, and renders unnecessary the injurious expedients of blocking up the body on the axle-case, or bending the shafts to bring them to the right line of draught. As a practical farmer's cart, it has many advantages. It is simple in construction, so as to be easily repaired by the rustic artisan, whilst it has great capacity, and is very low in the body. For exportation, it is capable of packing up in pieces, so as to occupy only twenty cubic feet.

SACK ELEVATOR.

Registered for Mr. Thomas Moore Sharp, *Belfast.*

This simple apparatus effects an important saving of human labour in warehouses and other situations, where heavy sacks have to be raised from the ground, and conveyed away on men's shoulders. It is in the lifting operation that the carrier's power is so rapidly consumed—the loss due to this operation, especially for short distances of conveyance, being about two-thirds of the whole force called into action. Mr. Sharp removes this loss, by furnishing the labourer with a means of economically applying his strength in the arduous task of elevating the weight. Our engraving represents a side elevation of the "sack elevator," as having just raised up its load. It consists merely of a timber frame, open at the front to admit the sack, which is placed against the inclined frame, A, and upon the lift board, B, suspended by four ropes from its four corners. These ropes pass over fixed pulleys, C, in the upper cross-bars of the frame, and are thence passed round corresponding pulleys, D, on a short horizontal shaft at the back of the frame. When a sack is to be raised, the board, B, rests on the floor, and the sack being set upon it, the attendant turns the winch-handle on the back pulley shaft, and thus with ease winds up the four supporting cords, and raises the sack to the required height, when it is held in the desired position by a moveable stop-pin, E, which holds the handle. It is stated that the "elevator" enables one man to accomplish the labour of three unassisted men.



REVIEWS OF NEW BOOKS.

Report of the Commissioner of Patents for the Year 1849. Part I. Arts and Manufactures. Washington, 1850.

The bold character of American invention is well illustrated in the remarkable volume before us. It gives us a peep into the recesses of that mass of novelties, in the production of which the citizens of the United States have earned so remarkable a reputation, and furnishes an eloquent example of that inordinate treading of inventors upon one another's heels, so often held up as the inevitable result of a system of excessively cheap patents.

The volume contains, in its eight sections, a financial and statistical account of the official proceedings for the year; general statement and classification of inventions; examiners' and machinists' reports; an article on the origin and progress of invention; another on the motors, chief levers of civilization; proposed application of the Government patent fund; historical notices of inventors and patentees; and an article on the propulsion of steamers.

It appears from the financial statement, that the whole number of applications for patents received during the year ending December 31, 1849, is 1,955; the number of caveats filed during the same period is 595. The whole number of patents issued during the year 1849, is 1,076; including 30 re-issues, 5 additional improvements, and 49 designs. No disclaimers have been entered during the year. Within the year 1849, 751 patents have expired. There were 11 applications to extend patents, the terms of which were about to expire; 7 of which were granted and 4 rejected. None have been extended by act of Congress within the year.

The number of cases on examiners' desks, January 1, 1849, was 539; the number of applications received during the year, 1,955, making the whole number of applications before the office for the year, 2,494. Of this number, 9 cases remained unexamined on the 31st December, 1849. The business of the office for the past year shows the examination of 2,485 applications, resulting in the issue of 1,076 patents, and 1,409 rejections and suspensions.

The commissioner devotes a considerable space to the consideration of a modification of the existing laws, which, like our own, are open to the charge of being "behind the times." He says—

"Inadequacy of protection is what is chiefly complained of—the violation of a right as sacred as any personal possession, without the remedy guaranteed against a petty larceny. It is manifestly unjust that the time and means of the inventor should be expended in defending that which Government accords as peculiarly his own, in every instance where a wilful trespasser is called upon to respond in damages for infringement. He is thus subjected to all the horrors of interminable and ruinous litigation; and if his assailants are more fortunate in having the means of attack than he of defence, his case is hopeless, and he may be likened, as once were chancery clients, to sheep, that, having taken shelter in the hedge, come forth 'piteously complaining,' leaving their fleece upon the bush.

"It may be contended that all other titles to property are justly subject to investigation without limitation; and that an exception in this instance would be a departure from the well-settled principles of practice and law. The argument might be good, were all property equally the result of mental creation, and equally susceptible of public invasion. Unlike a chattel, it can be stolen by one or a thousand, and by all at the same time. Its appropriation by one interposes no obstacle to its larceny by another, and thus the inventor is subject to be plundered by every person who chooses to violate his right. He appeals to the law for redress, and the remedy he adopts proves to be one of self-immolation."

According to the present enactments, a patentee may obtain a "re-issue," embodying matter not claimed in the original patent, if shown by the model and drawings. This, in effect, makes a new claim admissible, for what, originally, may not have been deemed of sufficient value to patent. The device having been a part of the first arrangement of the machine, is now claimed; and having been new at the date of the early patent, a right to the monopoly of it is set up. The grant of this right frequently interferes with the subsequent inventions of others, and is objectionable in the highest degree on this very ground. The commission, consequently, very sensibly recommends that no re-issue, containing a broader claim than the original, should be granted. In our eyes, a greater improvement would be, the removal of the odious embargo laid upon English inventors, in the shape of the 500 dollars tax.

The "examiners' and machinists' reports," with the remaining original articles which we have before specified, supply some very valuable information which deserves dissemination in the mother country. It is not often that we find reason to mention American book illustrations in favourable terms; but we are bound to state that these features in the present volume really deserve our good opinion. The frontispiece is an example of medallic engraving—a head of President Taylor, engraved as "a tribute of respect to his memory." The execution of this medallion, though confessedly inferior to similar works of ours, exhibits a great step in the art, on the part of the Americans. A specimen of chromo-lithography (here called "machine painting"), however, demands higher praise. It is by Mr. P. S. Duval of Philadelphia, and exhibits the gradual progress of the picture, from the "dreamy shadows" of the first dim blue tints of the primary impression, up to the rich and glowing finish of the ninth. The subject is allegorical, and is equally creditable for the drawing of the figures by Mr. C. Schuesele, as for the accuracy of the printer's handiwork—nine different stones being employed to bring in the varied outlines and tints.

CORRESPONDENCE.

DOMESTIC WASHING-MACHINE.

My sketches represent a simple and effective washing-machine, the adoption of which would, I think, lighten the labour of domestic servants very considerably. Fig. 1 is a perspective view of the apparatus, as complete for use; and fig. 2 is a detail of the rubbing movement detached. It is merely an oblong wooden vessel, made of inch deal, two feet six inches long, and fifteen inches wide, by one foot in depth. The washer is a broad segmental piece of wood, A, having a cross-handle attached for working it. The periphery of the segment is ribbed or toothed across its width, to fit to corresponding teeth or ribs, B, on the bottom of the vessel. The clothes, or articles to be washed, are laid evenly upon the ribbed bottom of the vessel, which has in it the usual washing liquid, and the washer, A, is then placed upon the top, and rocked to and fro by hand. This plan would answer well for cleaning heavy fabrics, such as the moleskin dresses of mechanics. It is also cheap, as it can be made at a cost of from 8s. upwards, according to size.

Fig. 2.

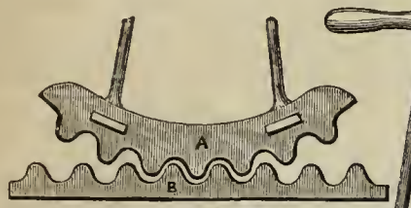
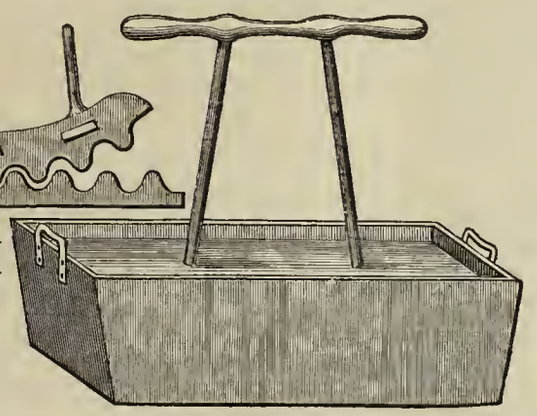


Fig. 1.



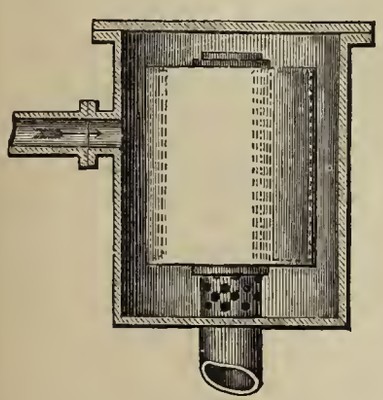
DIXON VALLANCE.

Greenshields, by Carnwath, Dec. 1850.

DISCHARGE-VALVE FOR WATER IN STEAM PIPES.

As I have repeatedly met with serious cases of annoyance, arising from the collection of the water of condensation in steam pipes and cylinders, I need not apologise for making public, through the pages of the *Practical Mechanic's Journal*, a float-valve apparatus, which I made some time ago, as a remedy for the evil.

My sketch represents the apparatus, the valve-case being in vertical section. The case contains a cylindrical copper float, having a tube passing through its axis, and fitting water-tight over a fixed interior tube, closed at the top. This inner tube forms the discharge-way for the water, and is bored with a series of small holes close to the bottom of the case, through which the tube passes. When the water flows into the case, as indicated by the arrow, it elevates the float to the position in which it is delineated. The water then flows off through the holes, and the falling of the float brings the outer tube over the holes, and stops the external communication. This plan works under any pressure of steam, as the pressure is the same at top and bottom. There is nothing particularly new in the plan; but as it answers its intended purpose, it may be worth explaining.



Johnstone, Dec., 1850. JOHN BRAIDWOOD.

[This arrangement has been pretty extensively introduced with a common conical-seated lift-valve; but Mr. Braidwood's simple substitute of the sliding tube and perforated pipe is an improvement, for more reasons than one, as the practical engineer will at once recognise.—ED. P. M. JOURNAL.]

HIGH-PRESSURE STEAM REGULATOR.

High-pressure engines are now frequently employed in operations where extreme regularity or uniformity of speed is essentially necessary. A great step towards securing this uniformity would be obtained by adopting a separate regulating-valve, placed before the usual governor throttle-valve. This valve I would make like the common throttle-valve, and connect it with the piston-rod of a small steam cylinder, to which a helical spring must be attached to balance the steam pressure. Steam, direct from the boiler, is conducted into the bottom of the cylinder, and, as the pressure increases, the corresponding rise of the piston closes the valve in the main steam-pipe, more or less, adjusting it so that the requisite quantity of steam shall pass through, and no more. Then, just as the steam pressure varies—and it must vary occasionally—the piston will rise or fall, and constantly adjust the flow, so as to keep up the pressure to the point necessary to work the engine. A graduated scale on the top of the cylinder serves to show the steam-pressure at any time, an index being carried by the piston-rod.

Johnstone, Dec., 1850. JOHN BRAIDWOOD.

ELASTIC FACES FOR LIFT-VALVES

I have been six years a subscriber to your *Practical Magazine* and *Journal*, and although I have not contributed a line in that time towards the work, yet I have been a warm admirer of its contents, considering it to fully carry out its title as a promoter of practical information.

In several of the late numbers I find that vulcanized India-rubber has been used for various purposes, such as railway buffers, and joints for steam pipes. Having an air-pump of 9 or 10 inches diameter to make for a double-cylinder steam-engine, I should like your opinion as to the propriety of facing the delivery-valve—which will slide upon the pump-rod, and shut down on the top of the barrel—with vulcanized India-rubber. There will be no foot-valve, as the air-pump is to stand in the middle of the condenser. GEORGE T. BLOOMFIELD.

Thelnetham, Suffolk, Dec., 1850.

[Vulcanized India-rubber will answer excellently, provided the heat is not too great. Our correspondent can easily settle this point himself, by subjecting pieces of the material to different degrees of temperature. —ED. P. M. JOURNAL.]

GRAVITATION PROPELLER FOR STEAMBOATS.

Observing that, in some of your late numbers, the mode of propelling steamers by the water-jet, as patented by Messrs. Ruthven, has been brought under notice, and conceiving that by their plan the capabilities of that system are not fully developed, may I request a corner in your columns, to suggest a different method of applying water, by which greater propulsive power may be attained?

The arrangement to which I allude, may be designated the "Gravitation Propeller," the propulsive effect being produced by the weight or reaction of water descending an inclined plane. That such an effect is thereby produced, may be proved in the simplest manner—the only apparatus required for that purpose being a small tin trough, say length 6 or 8 inches, breadth and depth 1 inch, open at one end, and closed at the other; placing this trough on a block of wood, or model of a boat, afloat, the open end towards the stern, and the closed end towards the stem, and at any given vertical angle. Then let a continuous stream of water be poured into the trough at the highest end, and a forward movement will immediately take place, proportionate to the quantity of water employed, and the angle at which the trough is placed.

This effect appears to be quite distinct from that of Ruthven's jet, projected either above or below the water line, but in practice it might be combined advantageously with both, whereby the aggregate result of these different plans would be obtained. Either one trough might be used, placed in the centre of a vessel, or one on each side, either internally or externally.

Montrose, December, 1850. J. B.

[Our correspondent's remarks were accompanied by a couple of rough outline sketches, which we have omitted, as unnecessary for the illustration of his idea. Our readers will, we think, agree with us, that he has failed in his attempt to show that this "gravitation propeller" differs at all from the existing schemes for reaction propulsion. It is true enough that there is some novelty in the practical details; for, to meet the requirements of the arrangement, the power of the engine must be expended in elevating the water to the level of the propelling head. What advantage is gained in this respect, we have yet to learn.—ED. P. M. JOURNAL.]

WIRE-ROPE SIGNALS.

In the current volume of your valuable *Journal*, page 112, I have observed the inquiry of your Parisian correspondent as to the invention and first application of the "Wire Signal;" and as the question does not appear to be satisfactorily settled, permit me, without laying any claim to the invention, to state what I know of the history of the improvement, and to observe, that if your correspondents generally would pursue the same course, some satisfactory conclusion as to its origin might probably be arrived at.

In the latter part of the year 1839, or the beginning of 1840, a collision occurred at the Whitacre Junction on the Derby and Birmingham Railway, at which place a wire signal was erected immediately afterwards, to protect the junction in future; and, at the same time, another wire signal was erected on the same line, to protect a drawbridge which carried the railway over a canal near Burton-on-Trent. These signals extended about a quarter of a mile from the points, and were each worked by two wires sliding parallel to each other in a wooden trough, laid along the side of the railway—the use of one wire being to *pull* the signal ON, and the other to *pull* it OFF. The signals consisted of a disc and a lamp fixed to a vertical pole, which being attached to an upright post by a collar near the top, turned upon a pivot at the bottom, and the working lever being also attached to a vertical turning post, it will be readily understood that the signals were worked by wires, in the same manner as machinery is worked by straps, the wires being fixed to horizontal pulleys, and the motion limited to just so much as was necessary for turning the signal on and off.

I do not know who was the inventor of these signals, but as Mr. Birkenshaw was engineer of the line at that time, they must have been fixed with his knowledge and sanction, and are most probably due to that gentleman.

The next wire signal that I have any knowledge of was fixed in the latter end of the year 1844, at the South Junction, near the Derby station, where it still remains; and so very important did this description of signal prove to be, that during the year 1845 it became extensively used on the Midland Railway, with some modifications made under the direction of Mr. Barlow, the company's engineer.

One modification consisted in the substitution of a balance-weight for the wire previously used for pulling the signal off. This weight is made to ascend when the signal is pulled on, and is sufficiently heavy to turn the signal off in its descent.

Another modification was the substitution of an iron tube, about two inches diameter, for the wood pole previously used for carrying the signals, the tube being intended for the introduction of a gas-pipe, where it is convenient to light the signal lamp with gas.

To obviate the inconvenience arising from the expansion and contraction of the wire under different temperatures, two adjusting screws, precisely similar to the ordinary carriage coupling, were introduced, one at each end of the wire, by which it may be kept in uniform tension.

The whole of the wire signals on the Midland Railway, upwards of 300 in number, are constructed with discs, so as to enable a driver to distinguish a distant from a station signal, the station signals being uniformly semaphores; but on the signals being afterwards introduced on the London and Birmingham line, they were constructed with arms *a la* semaphore, and the signal worked with vertical levers.

In fixing a wire signal, it is desirable that the signal should be so situate as to be within sight of the signalman, when he is turning it on or off, in order that he may be in no doubt as to its working properly; should it so happen, however, in consequence of deep cuttings, curves, or bridges, intervening, that it is necessary to carry the signal to such a distance from the turning post as to be out of sight of the signalman, the defect may be removed by introducing a small supernumerary signal, fixed within sight of, and at any convenient distance from, the signalman; and this should be connected to the principal signal rod by another wire, fixed with horizontal pulleys and connections, as before described, in such a manner that it could not act otherwise than simultaneously with the principal signal.

THOS. MERCHANT.

Midland Railway, Derby, December, 1850.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

NOVEMBER 19, 1850.

WILLIAM CUBITT, ESQ., PRESIDENT, IN THE CHAIR.

"The Ventilation of Collieries, theoretically and practically considered," by Mr. William Price Struve, of Swansea, M. Inst. C. E.

The author commenced by showing that the general principles which ought to govern the ventilation of collieries, were—

1st, That a current of air through the channels of collieries, at a velocity of five feet per second, was sufficient for most purposes.

2d, That a current exceeding that velocity would only be attained at the expense of leakage and other evils.

3d, That, in order to obtain the requisite supply of fresh air, the channels of a colliery or mine ought to be enlarged, according to the exigency.

In the process of laying out a mine, a subdivision occurred, by which the workings were apportioned into numerous compartments, which facilitated the system of splitting the current of air, or diverting it into numerous channels, giving to each compartment a separate, and, therefore, more effective ventilating force; at the same time the area of the channel was enlarged, and the aggregate length of the air tube shortened, so that it was quite practicable to pass through the workings of a mine, three hundred cubic feet of air per minute for each man employed.

The velocity of the air current in a mine was so easily affected, that it was important to consider by what accidents, and under what circumstances, any changes took place.

It could not be supposed that the excavated space of old workings was completely filled by the "falls" of the roof and "creeps" of the floor; extensive rupture of the stratification occurred, and through this broken ground great leakage must take place. This would seriously affect a long continuous air course; therefore, the way to meet this difficulty was to split, shorten, and enlarge the air channel. The details of two experiments at the Eaglesbush and Yuis David collieries, where the air was pumped out by Mr. Struve's mine ventilator, showed that a large proportion of the air was drawn from the old workings, and the "goaf," or broken ground surrounding the colliery, and did not come down the intake shaft, and traverse the actual workings, as it ought to have done.

In both these cases, the enlarging and splitting of the air channels, so as to reduce the velocity of the air to about three feet or four feet per second, would have produced most beneficial results.

These principles were shown to have been lost sight of in the majority even of the great collieries, and the power of rarefaction by a furnace was trusted to for dragging the long column of air over and through innumerable impediments. In some cases this was left to be produced by the increased temperature of the mine, from the candles, and the respiration of the men, aided by the cooling effect of water trickling down the intake shaft. These scarcely sufficed to produce an average difference between the two shafts of thirteen degrees in winter, whilst in summer, and in certain states of the atmosphere, there was no difference at all, and, consequently, little or no ventilation. Where rarefaction by heat was used, the temperature in the upcast shaft varied from ninety degrees to one hundred and sixty degrees; this, however advantageous for ventilation, was injurious to the shaft itself, and absolutely dangerous to the men who had to traverse it.

A comparison of the dimensions of the air passages and the velocities of the currents in numerous collieries, led to an estimate of the motive power required to produce the results attained in the best ventilated mines, in case of the employment of a steam-engine and air-pumps. This power would have varied between 23 horse power and 26 horse power.

The efficiency of furnace ventilation was always increased by the depth of the shafts, especially if they were entirely devoted for the purposes of ventilation irrespective of the working of the pit.

The experiments of Mr. Nicholas Wood, Mr. G. Elliot, Mr. H. Vivian, and other mining engineers, were then quoted, to demonstrate the insufficiency of the "steam jet" as a means of promoting ventilation, showing that it was a most wasteful application of power, when compared with the steam force employed to work Struve's mine ventilator at Eagleshush Colliery. This apparatus consisted of two hollow pistons, resembling large gasometers, plunging into cisterns of water, and having inlet and outlet valves. The pistons received alternate motion from a small steam-engine of 5 horse power; and being filled and emptied at each revolution of the crank, produced a regularity of current, and a degree of copious ventilation, hitherto unknown in the mines to which they had been applied. The small cost of their establishment—only about one hundred pounds for an extensive mine—joined with the little liability of getting out of order, was much in their favour.

The paper terminated with copious extracts from the able mining reports of Mr. John Phillips and Mr. Kenyon Blackwell, confirming all the positions assumed by the author.

SOCIETY OF ARTS.

NOVEMBER 13.

LORD OVERSTONE IN THE CHAIR.

Mr. Paxton read a paper descriptive of his "Design for the Building for the Exhibition of All Nations, and of the gradual development of the method of construction employed."

Mr. Paxton began by stating that the Great Exhibition Building was the development and result of a very long series of experiments made by him at Chatsworth, in the erection of the different horticultural buildings there, on which he had been engaged since the year 1828. The pine-house, built in 1833, was the first in which the ridge-and-furrow roof—an essential feature in the Great Building—was employed. This roof was contrived by Mr. Paxton, so that the glass in it might be more nearly at right angles to the slanting and weak, though valuable, rays of the morning and evening sun, than that in the straight roofs was. So well was it found to answer, that in 1834 he built a greenhouse, 97 feet 6 inches by 26 feet, with a mean height of 14 feet 6 inches; this building, even under the old glass

tax, cost only 2*d.* per cubic foot. It was followed in 1836 by a "curvilinear" hothouse, 60 feet by 26 feet, so called from the roof being a quarter circle: here the Victoria Regia first flowered in 1849. In the following year the Great Conservatory was commenced; and in order to economise labour in its construction, Mr. Paxton invented a machine for forming the sash-bars, by which he effected a saving of £1,400, and for which the Society of Arts, in 1841, gave him the silver medal. This has been the type of all the machines for wooden sash-bars since used.* For this building sheet-glass was first made, by the Messrs. Chance & Co., of the length of 4 feet, nothing beyond 3 feet having ever before been made. The Great Conservatory is 277 feet long, 123 feet wide, and 67 feet to the crown of its domed roof.

In a conservatory at Darley Dale, in 1840, Mr. Paxton first employed the ridge-and-furrow roof on a level, that is, neither curvilinear nor inclined, as in the former cases. The breadth of this building is 17 feet; and so successful was it, that, in a letter from the proprietor, it was said to be constantly used as a sitting-room by his family. This was more extensively carried out in the new Victoria Regia house, 60 feet 6 inches in length, and 46 feet 9 inches in breadth, with a clear span for the roof of 33 feet 6 inches, and which, on its small scale, is a perfect type of the Great Building.

The Industrial Building.

"My reason for offering a design for this building was this:—When plans for the structure were sent in by various parties to the Royal Commissioners, many forcible reasons were urged in the daily papers against the propriety of erecting a large building of bricks and mortar in Hyde Park. It was then that I turned my attention to the matter; when I was at once convinced that the least objectionable structure to occupy a public park would be an erection of cast-iron and glass, whilst, at the same time, a building of this description would be the very best adapted for the purposes of the Exhibition.

"The time for receiving the designs had expired; but, from having the whole matter already digested, and the system of ridge-and-furrow *flat* roofs so fully in my mind, it only required the adaptation of the principle on a large scale to suit the vast building for the Exhibition. My plans were got up in about ten days, and I had the satisfaction of their being ultimately approved of by the Commissioners.

"The design for the building was planned, first with particular consideration as to its fitness for the object in view, namely, the Exhibition of 1851; secondly, its suitableness for the site proposed; and lastly, with a view to its permanence as a winter garden, or vast horticultural structure, or a building which might, if required, be again used at any future period for a similar Exhibition to that of 1851.

"One great feature in the present building is, that no stone, brick, or mortar need be used, but the whole is composed of dry material, ready at once for the articles to be exhibited. By combination of no other materials but iron, wood, and glass, could this important point be effected; which, when we consider the limited period allowed for the erection of so stupendous a structure, may almost be deemed the most important object. The absence of any moist material in the construction, together with the provision made for the vapours which must arise and be condensed against the glass, enables the exhibitor at once to place his manufactures in their respective situations, without the probability of articles, even of polished ware, being tarnished by their exposure.

"I may state, that it is unnecessary to cut down any of the large timber trees, provision being made by means of a curvilinear roof over the transept for their reception within the building; and, by a proper diffusion of air, they will not suffer by the enclosure.

"The dimensions of the building are 1851 feet in length, and 456 feet in breadth in the widest part. It covers altogether more than 18 acres; and the whole is supported on cast-iron pillars, united by bolts and nuts, fixed to flanges turned perfectly true, and resting on concrete foundations. The total cubic contents are 33,000,000 feet.

"The six longitudinal galleries, 24 feet in width, running the whole length of the building, and the four transverse ones of the same dimensions, afford 25 per cent. additional exhibiting surface to that provided on the ground-floor. This extra space is suited for the display of light manufactured goods; and from it a complete view of the whole of the articles exhibited, together with an extensive view of the interior of the building, will be obtained.

"The roof is built on the ridge-and-furrow principle, and glazed with British sheet-glass, as previously described; the sheets being 49 inches long, *i. e.* an inch longer than those of the Great Conservatory at Chatsworth. The rafters are continued in uninterrupted lines the whole length of the building. The transept portion, although covered by a semicircular roof, is also on the angular principle.

"All the roof and upright sashes being made by machinery, are put together and glazed with great rapidity; for, being fitted and finished before they are brought to the ground, little more is required on the spot than to fix them.

"The length of sash-bar requisite is 205 miles. The quantity of glass required is about 900,000 feet, weighing upwards of 400 tons. All round the lower tier of the building, however, will be boarded, with fillets planted on in a perpendicular line with the sash-bars above.

"The gutters are arranged longitudinally and transversely: the rain-water passes from the longitudinal gutter into a transverse gutter over the girders, and is thus conveyed to the hollow columns, and thence to the drains below. As these transverse gutters are placed at every 24 feet apart, and as there is a fall in the longitudinal gutters both ways, the water has only to run a distance of 12 feet before it descends into the transverse gutters, which carry it off to the hollow columns, or down-pipes. The grooves for carrying off the moisture which condenses on the inside of the glass are cut out of the solid; in fact, the whole gutter is formed by machinery at one cut. The gutter is cambered up by tension-rods, having screws fixed at the ends, so as to adjust it to the greatest nicety, as is the case with the wrought-iron girders which span the Victoria Lily House.

"Floors.—I have tried many experiments in order to find out the most suitable floors for the pathways of horticultural structures. Stone was objectionable, chiefly on account of the moisture and damp which it retained. The difficulty of getting rid of the waste from the watering of plants was also an objection; but perhaps the greatest is the amount of dust from sweeping. I likewise found that close-boarding for pathways was open to many of the same objections as stone; for although damp and moisture was in part got rid of, yet still there were no means of immediately getting rid of dust. These various objections led me to the adoption of trellised wooden pathways, with spaces between each board, through which, on sweeping, the dust at once disappears, and falls into the vacuity below.

"Whilst the accomplishment of this point was most important in plant-houses, it is doubly so with the Industrial Building, where there will be such an accumulation of various articles of delicate texture and workmanship. Before sweeping the floors, the whole will be sprinkled with water from a moveable hand-engine, which will be immediately followed by a sweeping-machine, consisting of many brooms fixed to an apparatus on light wheels, and drawn by a shaft. Thus a large portion of ground will be passed over very quickly.

"The boards for the floor will be 9 inches broad and 1½ inch thick, laid half an inch apart, on sleeper-joists 9 inches deep and 3 inches thick, placed 4 feet apart.

"This method of flooring, then, possesses the following advantages:—It is very economical; dry, clean, pleasant to walk upon; admits of the dust falling through the spaces; and even when it requires to be thoroughly washed, the water at once disappears betwixt the openings, and the boards become almost immediately fit for visitors.

"The galleries will be laid with close-boarding.

"Ventilation of the Building.—This point has been most carefully considered, and a most copious supply of pure air is provided.

"Four feet round the whole of the basement part of the building is made of *louvre-boarding;* and at the top of each tier a similar provision of 3 feet is made, with power to add an additional quantity if required. In the centre aisle, also, the air will be plentifully admitted. By simple machinery, the whole can be regulated with the greatest ease. The advantages of this kind of ventilation are several. Louvre-boards are very simple in construction. They can be opened and closed instantaneously with the greatest readiness. They nicely distribute the air, and yet admit a large volume of it; and, from the manner in which they are placed over each other, they effectually prevent the entrance of wet in rainy weather.

"A provision will be made for the Indian method of ventilation, if the heat is so intense as to render it desirable to have the temperature lower than out of doors.*

"In order to subdue the intense light in so large a building covered with glass, all the south side of the upright parts, and the whole of the angled roof, will be covered outside with canvas or calico, so fixed as to allow a current of air to pass between the canvas and the roof; in very hot weather, water may be poured on, which will very much assist in lowering the temperature within.

"This sort of covering offers the following advantages: the brightness of the light will be tempered and subdued; the glass will be protected from the possibility of injury by hail; the screen being on the outside, will render the building much cooler than if it were inside; and the ventilation can then be regulated at pleasure.

"From the side galleries, running the whole length of the building, there will be grand views of the goods and visitors below, whilst the transverse galleries in the middle and at the ends will afford ample means for general supervision, and will serve to communicate between the side galleries.

"Magnifying-glasses, working on swivels, placed at short distances, will give additional facility for commanding a more perfect general view of the Exhibition.

"After the Exhibition is over, I would convert the building into a permanent winter-garden, and would then make carriage-drives and equestrian promenades through it. There would be about two miles of galleries, and two miles of walks upon the ground floor, and sufficient room would be left for plants. The whole intermediate spaces between the walks and drives would be planted with shrubs and climbers from temperate climates. In summer, the upright glass might be removed, so as to give the appearance of a continuous park and garden.

"I have now endeavoured to give a brief outline of the Exhibition Building of 1851. It will be seen, from the simplicity of all its parts, together with the simplicity of the detail, that the construction does not offer a subject for long description. The section of one part shows the whole; for it is only by the multiplication of these parts that the stupendous structure now in progress is extended.

"When I consider the cheapness of glass and cast-iron, and the great facility with which it can be used, I have no doubt but many structures similar to that at Darley will be attached to dwelling-houses, where they may serve as sitting-rooms, conservatories, waiting-rooms, or omnibus-rooms, if I may be allowed the expression. I am now, in fact, engaged in making the design for a gentleman's house, to be

* Transactions of the Society, vol. liii. pt. i. page 97.

* "A house was fitted up last summer at Chatsworth, as an experimental place to try this mode of ventilating, when it was found to answer the purpose admirably. The temperature was reduced in an hour from 85 to 78 degrees, without any other means being used to increase the draught through the building."

covered wholly with glass; and when we consider that, wherever lead is now used, glass may, with equal propriety, be substituted, I have every hope that it will be used for buildings of various conditions and character. Structures of this kind are also susceptible of the highest kind of ornamentation in stained glass and general painting.

"I am not without hope, however, that it will become almost universal in its use, and that the system will be extended for manufacturing purposes, as well as general cemeteries, and also for horticultural buildings, so that even market-gardeners will advantageously apply it in the growing of foreign fruits for the London markets.

"In short, there is no limit to the uses to which this material may be applied—no foresight can define the limits where it will end; and we may congratulate ourselves that, in the nineteenth century, the progress of science and the spirit of manufacturers have placed at our disposal the application of materials which were unknown to the ancients, and thereby enabled us to erect such structures as would have been deemed impossible even in the early part of the present century."

The paper was accompanied by a very large number of drawings, views, and diagrams, and by one of the sash-bar machines. The most interesting illustration was a specimen of the leaf of the Victoria Regia, five feet in diameter, the growth of five days. The under side of the leaf presents a beautiful example of natural engineering in the cantilevers which radiate from the centre, where they are nearly two inches deep, with large bottom flanges and very thin middle ribs, and with cross girders between each pair to keep the middle ribs from buckling; their depth gradually decreases towards the circumference of the leaf, where they also ramify.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—TWENTIETH MEETING.—Edinburgh, August 1, 1850.

Section A.—Mathematical and Physical Science.

"On the Lunar Surface, and its relation to that of the Earth," by Mr. Nasmyth.

The subject was illustrated by a series of drawings which the writer has executed by the aid of a powerful telescope, which he has made for himself for the express purpose of following up his investigations on the subject in question. These appear from the drawings exhibited, and the description given by Mr. Nasmyth, to afford striking illustrations of the nature and action of some of those agencies, which in remote periods of the earth's geological history have given to its surface many of its most remarkable features; namely, as to the causes of volcanic action, the protrusion of igneous rocks, the upheaving of mountain ranges, as well as the submersion of extensive portions of the earth's surface,—all of which vast geological phenomena Mr. Nasmyth appears to assign to a few grand and simple prime causes, resulting from the consolidation and alternate contraction of the crust and interior of the earth and moon—both of which planets appear to have originally been in a molten condition. After drawing attention to the vast number and magnitude of crater-formed mountains with which every portion of the moon's surface appears to be covered, Mr. Nasmyth proceeded to give the reasons for the conclusion, that these crater-formed mountains are really the craters of extinct lunar volcanoes; pointing out the frequent occurrence of the central cone, the result of the last eruptive efforts of an expiring volcano, a feature so familiar to all those who have observed volcanic craters on the earth's surface. This central cone Mr. Nasmyth showed to exist in the majority of the lunar craters; and thereby drew the conclusion, that they were the result of the same kind of action which has produced them on the volcanoes of the earth. The cause of the vast numbers of such volcanic mountains with which the lunar surface is bespattered was next considered, and traced to the rapid consolidation and contraction of the crust of the moon, whose mass or bulk being only $\frac{1}{64}$ of that of the earth, while its surface is the $\frac{1}{16}$, has, in consequence of these proportions, a radiating or heat-dispensing surface four times greater than that of the earth in relation to its bulk. From this geometrical consideration Mr. Nasmyth explained how it was that, by the rapid cooling and collapse of the crust of the moon on its molten interior, the fluid matter under the solid crust was by this "hide-binding" action forced to find an escape through the superincumbent solid crust, and come forth in those vast volcanic actions which, in some remote period of time, have covered its surface with those myriads of craters and volcanic features, that give to its surface its remarkable character. The cause of the vast magnitude of the lunar craters was next alluded to; and assigned, as in the former case, to the rapid and energetic collapse of the moon's crust on its yet molten interior,—the action as regards *the wide dispersion* of the ejected matter being enhanced by the *lightness* of the erupted matter, seeing that the force of gravity, which gives the quality of *weight* to matter on the moon as on the earth, is so very much less on the surface of the moon than on the earth,—so that the collapse action had to operate on material probably not half the weight of cork, bulk for bulk. The causes of those vast ranges of mountains seen on the moon's surface was next touched on; and Mr. Nasmyth endeavoured to explain them by the continued progress of the collapse action of the solid crust of the moon crushing down or following the contracting molten interior, which, by the gradual dispersion of its heat, would retreat from contact with the interior of the solid crust, and permit the crust to crush down and so force that portion of the original surface *out of the way*, and in consequence of this action assume the form and arrangement of mountain ranges. Mr. Nasmyth, in illustration of this important action, adduced the familiar case of the wrinkling of the surface of an apple, by reason of the contraction of the interior, and the inability of the *surface* to accommodate itself to the change otherwise. The mountain ranges in question Mr. Nasmyth considers to be nothing more or less than the material which, in the original expanded globes, formed the comparatively level crust of the moon and earth. The fall of the unsupported crust on the retreating nucleus resulting in a tremendous splash on the subjacent molten mass, was described to yield a very probable explanation of the appearance of granitic and igneous centres of certain mountain ranges, as well as the injection of igneous rocks in the form of trap dykes and basaltic formations, which appear to have come forth in this manner from below the crust of the earth, and overlay formations of comparatively very recent formation. The origin or cause of those bright lines which radiate from certain volcanic centres on the moon's surface (Tycho, for instance) is alluded to, and illustrated by a very striking experiment of causing the surface of a globe of glass filled with water to collapse on the fluid interior, by rapidly contracting the surface while the water had no means of escape. The result was the splitting or cracking up of the surface of the globe in a multitude of radiating cracks, which bear the most remarkable similarity to those on the moon. Mr. Nasmyth further illustrated this subject by reference to the manner in which the surface of a frozen pond may be made to crack by pressure from underneath,—so yielding radiating cracks from the centre of convergence, the chief discharge of water will take place, while simultaneously all along the lines of radiating cracks the water will make its appearance,—thus explaining how it is that the molten material, which had in like manner been under the surface of the moon during that period of its history, came forth simultaneously up through the course of the cracks, and appeared on the surface as basaltic or igneous overflow, irrespective of surface inequalities.

MONTHLY NOTES.

Greaves' Portable Metronome.—This is a cheap substitute for Maelzel's well-known metronome, or time measurer for musical performances. It consists simply of a little flat weight suspended from a taper, graduated on one side from 60 to 160—the number of vibrations per minute—and marked on the other side with all the Italian musical rates, from *Adagio* to *Presto*. The upper end of the tape is attached to any fixed point, such as the corner of a music-stand, by a small spring-holder, rendering it easily adjustable at a moment's warning. In shortening the length of tape forming the pendulum, it is rolled up with the weight or "hoh," which is adjustable at any height, by a sliding detent on the latter. The tape is 40 inches long, and the whole, when wound up, is small enough to be carried in the waistcoat pocket. By rolling up or letting down the pendulum weight, any required number of vibrations may be obtained, in accordance with the index graduations; and whilst its action is as good as Maelzel's, it is immeasurably simpler and cheaper. Its vibrations are kept up by an occasional touch of the finger—a single impulse being sufficient to keep up its movement long enough for the execution of several pages of music.

Poupard's Curved Beam Weighing-Machine.—This is one of those little "practical ingenuities," the extreme simplicity of which almost takes away the imposing title of an invention, whilst the result gained by its adoption, shows it to be a satisfactory step towards perfection. In the ordinary scale-beam weighing-machine of the shop counter, a set of levers, forming a species of parallel motion, must be used to keep the scale plates sufficiently high up in a horizontal position, to clear the beam. To avoid this complication, with the inaccuracy arising from a compound movement, M. Poupard curves his beam upwards, from the fixed centre towards each scale plate, thus allowing the latter to be brought quite close to the bearing on the beam.

Domestic Ice-Making.—We have received from Apalachicola, U. S., some notes of an invention by Dr. Gorrie of Florida, for the artificial production of ice, on the large scale. The process appears to have made considerable noise amongst our American neighbours, who evidently look upon it as one of the greatest novelties of the day; but, in reality, not only is the idea of pretty ripe years, but, as we shall presently show, it has actually long since become a practical fact here. To such of our readers as have perused Professor Smyth's excellent paper "On Cooling the Air of Rooms in Tropical Climates"—in our October and December numbers—a detailed account of Dr. Gorrie's plan will be unnecessary for their comprehension of the involved principle. Professor Smyth compresses his air, cools it whilst in its highly condensed state, and, allowing it to expand, admits it in its cooled condition to the apartment under treatment. It is by an extension of this process that the American philosopher produces ice. Instead of setting free the condensed air in the open space of a room, he causes it to expand in contact with water, from which it absorbs the heat due to its expansion, that is, an amount of caloric necessary to replace the loss sustained in the previous cooling process. In other terms, a transfer of heat from the warmer water to the colder expanding air, to an extent sufficient to balance the difference between them. The two plans then are identical—By one, the air we are to breathe is lowered to a temperature more suitable to European frames; by the other, the temperature of a body of water is reduced, for the production of that equally great luxury, ice. Dr. Gorrie's apparatus consists of a couple of pumps worked in connection—that is, both driven from the same shaft. One of these pumps is the air-condenser, the other acts as the air-expander; the object of such a plan being, to economise power as far as may be, by causing the expansion in the latter, to assist the condensing action in the former. The heat evolved during this condensation is annihilated by a jet of water thrown into the pump, by a third pump of small size. On the contrary, in the expanding pump, the heat which must be taken up by the cooled air, in the reproduction of its elasticity, is abstracted from a supply of water, introduced by a fourth pump of the smaller class. This water is drawn from a cistern, injected amongst the expanding air, and again returned to the cistern. It is thus that the water-cistern becomes a cold reservoir, and furnishes the means of freezing liquids placed within it. As far as four or five years back, Sir John Herschel proposed a similar plan for making ice, not as a mere philosophical experiment, but "as practically applicable to the

manufacture of ice on the great scale, the only question being that of remunerative cost as compared with that of importation." He says, "an old steam boiler, buried some twenty or thirty feet under ground in well-rammed earth, and furnished with a condensing pump, worked above ground and one eduction pipe opening by a stop-cock, through a rose into water, would in all probability supply ice *ad libitum*, for the use of a family in this country; the condensation being performed over-night." It is also on record, that our early locomotive engineer, Trevethick, actually made some ice-machines of this kind. We must, however, accord to Dr. Gorrie the credit, not merely of being an independent discoverer, but of being the first to demonstrate the practicability of the scheme on a scale of some magnitude. Obviously the question of cost turns upon the amount of power expended in working the pumps, the machinery being comparatively of slight moment. We are told that pumps of one foot cubical capacity, worked at a temperature of 90°, are sufficient for the production of a ton of ice per day, and the original imperfect machine easily lowers a large mass of water at this temperature down to 5° or 10° below zero. It is further stated, that at a mean atmospheric temperature of 70° Fahr. half a horse power will make a ton of ice per day of 24 hours. At 85° a horse power, and at 90° one and a half horse power, will be required to give this quantity. On a large scale, say 10 tons per day, the consumption of power would of course be proportionally less. If practice confirms these theoretical deductions, the ice manufacture will soon be engrafted amongst the domestic operations of every family, and the days of "Wenham" will be numbered.

Mr. Hullmandel the Lithographer.—The death of this distinguished artist has just been announced in the newspapers. Even if his artistical reputation had been of less count than every admirer of lithography knows it really to be, the friend and contemporary of the great Senefelder would at least demand some notice as historically connected with the art. Although of French extraction, Mr. Hullmandel was a native of London. As he grew up, he evinced a strong love for the painter's art, and when quite a youth, travelled over a great part of the Continent in search of subjects for his ever-ready pencil. Having met with Senefelder in Munich, he learned from him the details of the new process. He at once purchased a press for the reproduction of his own drawings, and brought it over to this country, where he executed the first lithographs ever produced in Great Britain. His productions rapidly attracted attention, and his rooms soon became a school for the practice of the art. Under Faraday, he got himself well grounded in chemistry, and thus went to the root of the process at once, and his whole life, from this time, was made up of a continued series of brilliant successes. To recapitulate his performances would be to write a lithographic history. He invented the "tinted style," "printing in colours," and the "stump," and overcame the great difficulty of "lithotint," that is, the drawing on the stone with a brush of lithographic ink, long declared by the Institute of France to be impossible. The patent lists alone would show with what eagerness he pursued his occupation—and he was closely engaged in his efforts at improvement, up to his latest days.

Provisional Registration of Designs.—We have received the official regulations issued under this act. Designs, *Useful or Ornamental*, may be provisionally registered on and after the 1st January, 1851. The fee in the former case being 1s., and in the latter 10s.

Messrs. Pim's New Marine Boiler.—This improvement in marine mechanism, which we have elsewhere figured and described in the present pages, has just received a further test in its application to the "Sarnia" steamer, the last of two vessels just completed for the London and Channel Isles stations. The makers inform us that the boiler is being extensively introduced into the Mercantile Marine Steam Service.

Tyne Ship-Building.—An iron East Indiaman is now being built on the Tyne by Messrs. Coutts & Parkinson, for the Clyde. This is a curious fact, and speaks volumes of the extraordinary facilities which the locality affords for this class of engineering construction. Scarcely less startling is the fact, that Messrs. Miller and Ravenhill, the Thames engineers, are establishing a building-yard near Walker, on the Tyne, where they mean to build all their iron hulls, leaving the engine fittings to be completed on the Thames.

Modern Malleable Iron Making.—Messrs. Tod & M'Gregor of Glasgow have just now, in their marine engine shops, some wrought-iron beam plates 17 feet long, 4 feet 8 inches broad at the widest part, and 1⅛ inch thick. It is scarcely necessary to say, that these immense plates are the largest ever rolled—their weight exceeds 24 cwt. They are intended for marine-engine beams; and, since their arrival, Messrs. Tod & M'Gregor have ordered four additional ones, from the Derwent Iron Works, Consett, where the first were made. As a proof of the rapid progress in the art of rolling large plates, it may be mentioned that, so recently as the erection of the great tubular bridges, considerable difficulty was experienced in getting plates of only 6½ cwt. for the tubes. Yet the 24 cwt. plates now produced are perfectly sound and good.

Cabinet-Makers' Art-Union.—We have given this name to a promising scheme lately set afloat in London, for the organization of a system of art instruction amongst the class of working cabinet-makers more directly connected with ornamentation. In Tottenham Street, Tottenham Court Road, a species of museum is now opened to such of the craft as choose to avail themselves of its advantages, which it offers in the shape of casts of fine examples of carving, prints and drawings, and a stock of books, and the intercommunication of varieties of minds. Such an institution, if judiciously managed and carefully restricted to its legitimate objects, may be productive of much good.

Rettie's Sewer Traps.—This clever apparatus has been very successfully introduced in Edinburgh, under the auspices of the Commissioners of Police, during their recent sanitary improvements. The passage of vermin is effectually prevented by them, and, what is of more moment, the noisome effluvia from the sewers and drains is completely shut off from connection with the outer air.

ENGLISH PATENTS.

Sealed from 23 l November, to 20th December, 1850.

James Bendall, Woodbridge, Suffolk, machinist,—"Improvements in certain agricultural implements."—November 23d.

George Shepherd, Holborn-bars, London, civil engineer, and Charles Button, of the same place, operative chemist,—"Certain improvements in the means or appliances used in conveying telegraphic intelligence between different places."—23d.

Christopher Nickels, York-road, Lambeth, Surrey, gentleman,—"Improvements in the manufacture of woollen and other fabrics."—23d.

John Hamilton, Prince's-square, Glasgow, and John Weems, Johnstone, Scotland,—"Improvements in warming and ventilating buildings and structures."—25th.

Henry Duncan Preston Cunningham, Bury, Hants, paymaster and purser in the Royal Navy,—"Improvements in reefing sails."—30th.

Frederick Buonapart Anderson, Gravesend, Kent, optician,—"Certain improvements in spectacles."—30th.

Robert Olddiss Bancks, of the firm of Bancks, Brothers, Weirhouse Mill, Chesham, Bucks, and 20 Piccadilly, London, paper-makers and card-makers,—"Improvements in the manufacture of paper."—30th.

Francis Frederick Woods, Pelham-terrace, Brompton, Middlesex, builder,—"Improvements in paving."—30th.

John Ainslie, Alperton, Middlesex, now residing at Perry-hill, Sydenham, Kent, draining engineer,—"Certain arrangements and apparatus for the manufacture of bricks, tiles, and other articles made from clay and other plastic substances, parts of the said arrangements and apparatus being applicable to the treatment and preparation of earths, minerals, animal and vegetable matters."—30th.

James Augustus Elmslie, and George Simpson, Union-buildings, Leather-lane, Holborn, importers of quicksilver and tin-foil manufacturers,—"Improvements in sheathing ships, and in protecting and confining gunpowder, and certain compounds thereof, and in the materials used for such purposes."—30th.

Henry Potter Burt, Blackfriars-road, Surrey, civil engineer,—"Improvements in the manufacture of window-blinds."—30th.

William Henry Ritchie, Kennington, Surrey, gentleman,—"Improvements in stoves."—30th.

Joseph Engene Chabert, Paris, France,—"Improvements in machinery for washing and drying linen and other fabrics."—30th.

Richard Barber, Hotel-street, Leicester, late cotton-winder,—"Improvements in the manufacture of reels for reeling, and stands for reels, which improvements are applicable to the manufacture of desk or wafer seals."—30th.

Henry Jules Boril, Boulevard, Poissionere, France, engineer,—"Improvements in the manufacture of bricks."—30th.

Charles Rowley, Birmingham, manufacturer,—"Improvements in the manufacture of dress pins, and other dress fastenings and ornaments."—30th.

Richard Blakemore, Leys, Ganerew, Herefordshire, Esq., M.P.,—"Improvements in the construction of ploughs."—30th.

John Platt, Oldham, Lancashire, engineer,—"Certain improvements in machinery or apparatus for spinning and doubling cotton, and weaving cotton, flax, and other fibrous substances."—December 2d.

Thomas Watson, Rochdale, Lancashire, hat manufacturer,—"Improvements in the manufacture of hat plush, and also in machinery or apparatus employed in such manufacture."—2d.

Richard Shiers, Oldham, Lancashire, manufacturer, and James Heginbottom, of the same place, manager,—"Improvements in the manufacture of textile fabrics."—2d.

Julian Bernard, Green-street, Grosvenor-square, gentleman, and Jean Baptiste Dureuille, 30 Cité de l'Etoile, Thermes, France,—"Improvements in the manufacture or production of boots and shoes, and in the materials and machinery or apparatus to be employed therein."—4th.

Benjamin Hinley, Birmingham, brassfounder,—"Improvements in the manufacture of castors."—5th.

Joseph Alexander Franklinsky, Stanhope-place, Middlesex, gentleman,—"Improvements in public carriages for the conveyance of passengers."—5th.

Ewald Riepe, Finsbury-square, London, merchant,—"Certain improvements in refining steel."—5th.

Henry Walker Wood, Briton Ferry, near Neath, Glamorganshire, gentleman,—"Improvements in the manufacture of fuel."—7th.

Samuel Rayner, Berner's-street, Oxford-street, Middlesex, artist,—"Improvements in paving."—7th.

Archibald Turner, Leicester, manufacturer,—"Improvements in applying heat for generating steam for motive power and for other purposes, and in generating heat, and in heating and evaporating fluids."—7th.

James Thomson Wilson, Stratford-le-Bow, Middlesex, chemist,—"Improvements in the manufacture of alum, and in obtaining ammonia."—7th.

Francis Papps, Camberwell, chemist.—"Improvements in metallic and other bedsteads, mattresses, and curtain rods, and in the coating or covering of bedsteads, and other articles wholly or in part composed of metal."—7th.

Alexander Mein, Glasgow, accountant,—"Certain improvements in treating the fleeces of sheep when on the animals."—(Being a communication.)—7th.

John Mortimer, Hanover-square, Middlesex, Esq.,—"Improvements in the magnetic needle and mariner's compasses."—7th.

George Henry Voyez, Acton-street, Middlesex, artist,—"Improvements in the manufacture of paper hangings."—7th.

James Ward Hoby, Glasgow, engineer,—"Improvements in the construction of the permanent way of railways."—7th.

John Everest, Tonbridge, Kent, and George Osborne, of the same place,—"Certain improvements in commodes, and in fixed and portable water-closets."—7th.

David Lloyd Williams, Thornhill, Llandilo, Carmarthen, gentleman,—"Certain improvements in furnaces."—7th.

William Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in engines to be worked by steam or other power."—7th.

Richard Archibald Brooman, Fleet-street, London, patent agent,—"Improvements in agricultural machines."—(Being a communication.)—7th.

Peter Wood, of the firm of Thomas Bury and Co., dyers, calenderers, and finishers, Adelphi Works, Salford, Lancaster—"Improvements in figuring and ornamenting woven fabrics, and in machinery employed therein."—11th.

Alfred Vincent Newton, Chancery-lane, mechanical draughtsman,—"Improvements in cutting and dressing stone."—(Being a communication.)—12th.

Alfred Vincent Newton, Chancery-lane, mechanical draughtsman,—"Improvements in the manufacture of iron hurdles or fences, and of certain other articles in the construction of which wirework is or may be employed."—(Being a communication.)—12th.

William Beckett Johnson, Manchester, Lancaster, manager,—"Certain improvements in steam-engines, and in apparatus for generating steam; such improvements in engines being wholly or in part applicable where other vapours or gases are used as the motive power."—12th.

John Mason, Rochdale, Lancaster, machine-maker, and George Collier, Halifax, York, manager,—"Certain improvements in preparing cotton and other textile materials for spinning, and in tools or apparatus for making cards and other parts of such preparing machinery, and in engines for giving motion to the same, which engines are also applicable in other cases where motive power is required."—12th.

Samuel Baxter, Wapping, Middlesex, shipwright,—"Improvements in apparatus for lifting, and for facilitating the working or steering of ships."—12th.

Thomas Hoskins Howels, Amelia-row, Land-port, Portsea, Hants, gunner,—"Improvements in gun-carriages."—12th.

Joseph Bennett, Deptford, Kent, engineer,—"Certain improvements in doors, window-shutters, and blinds."—12th.

Edmund Morewood, Enfield, Middlesex, gentleman, and George Rogers, of the same place, gentleman,—"Improvements in coating or covering metals."—12th.

Jean Aime Marnois, Lyons,—"Improvements in the manufacture of indigo."—(Being a communication.)—12th.

Joseph Baldwin and George Collier, both of Halifax, mechanics,—"Improvements in the manufacture of carpets and other fabrics."—12th.

George Royce, Fletland, Lincoln, miller,—"Improvements in grinding, dressing, and cleaning corn and seed."—12th.

George Benjamin Thorneycroft, Wolverhampton, Stafford, iron-master,—"Improvements in the manufacture of crank-axles."—12th.

Charles Cowper, Southampton-buildings, Chancery-lane, patent agent,—"Improvements in the manufacture of tiles."—(Being a communication.)—19th.

David Auld, Glasgow, engineer,—"Certain improvements in steam-engines, and in the working of steam boilers or generators, and in apparatus connected therewith."—19th.

Sebastiano Botturi, No. 7 Place de la Bourse, Paris, civil engineer,—"Certain improvements in machinery and apparatus for elevating fluids, and in their application as a motive power."—19th.

Adolphus Oliver Harris, High Holborn, philosophical instrument maker,—"Improvements in barometers."—(Being a communication.)—19th.

George Henry Bachhoffner, Grove-road, St. John's Wood, Middlesex, and Nathan Defries, Grafton-street, Fitzroy-square, civil engineer,—"Improvements in obtaining light and heat, and in apparatus connected therewith."—19th.

Edward d'Orville, Manchester, merchant, and John Partington, Wichen Hall, near Rochdale, in the same county, bleacher,—"Certain improvements in finishing thread or yarn."—19th.

Henry Mortlock Ommanney, Chester, Esq.,—"Certain improvements in the manufacture of steel."—19th.

John George Taylor, Great St. Thomas Apostle, London, merchant,—"Improvements in the manufacture of dress and other pins, and other dress fastenings and ornaments."—19th.

William Henry Green, Basinghall-street, London, gentleman,—"Improvements in the preparation of peat and other ligneous and carbonaceous substances, and in the conversion of some of the products derived thereby, and in the mode of their application to the preservation of substances liable to decomposition and destructive agencies, and which mode is also applicable to other products of a similar nature."—(Being a communication.)—19th.

Philip Nind, Leicester-square, gentleman,—"Improvements in the manufacture of sugar, and in cutting and rasping vegetable substances."—(Communication.)—19th.

John Henry Pape, Paris,—"Improvements in musical instruments."—20th.

William Herbert Gossage, Stoke Prior, Worcestershire, chemist,—"Improvements in the concentration of sulphuric acid, and certain other fluids; also, in the use of a certain product, or certain products, sometimes obtained in manufacturing sulpburic acid and sulphurets."—20th.

SCOTCH PATENTS.

Sealed from 22d November, to 22d December, 1850.

Jules Le Bastier, Paris, France, bnt temporary of Frankfort-on-the-Main, Germany, gentleman,—"Certain improvements in machinery or apparatus for printing."—27th November.

Alfred Vincent Newton, Office for Patents, 66 Chancery-lane, London, mechanical draughtsman,—"Improvements in the preparation aud manufacture of caoutchouc or India-rubber."—(Communication.)—27th.

Isaac Lewis Pulvermacher, Vienna, engineer,—"Improvements in galvanic batteries, in electric telegraphs, and electro-magnetic and magneto-electric machines."—28th.

Guilliaume Ferdinand de Douhet, Clermont Ferrand, France, gentleman,—"Certain improvements in the disoxigenation and the mutual reoxigenatiou of certain bodies, and the application of the products therefrom, either separately or simultaneously, to various useful purposes."—28th.

George Benjamin Thorneycroft, Wolverhampton, Stafford, ironmaster,—"Improvements in the manufacture of crank axles."—2d December.

David Napier, and James Murdoch Napier, York-road, Lambeth, Surrey, engineers,—"Improvements in apparatus for separating fluid from other matter."—2d.

David Auld, Glasgow, North Britain,—"Certain improvements in steam-engines, and in the working of steam boilers or generators, and in apparatus connected therewith."—2d.

Jean Aimé Marnas, Lyons, France,—"Improvements in the manufacture of indigo."—2d.

Peter Wood, of the firm of Thomas Bury & Co., dyers, calenderers, and finishers, Adelphi Works, Salford, Lancashire,—"Improvements in figuring and ornamenting woven fabrics, and in machinery employed therein."—4th.

William Melville, Roebank Works, Lochwinnoch, Renfrewshire, North Britain, calico printer,—"Certain improvements in weaving and manufacturing and printing carpets and other fabrics."—6th.

Peter Armand Le Comte de Fontainemoreau, 4 South-street, Finsbury, London,—"Certain improvements in oscillating engines."—(Communication.)—7th.

Alfred Vincent Newton, Office of Patents, 66 Chancery-lane, London, mechanical draughtsman,—"An improved composition, applicable to the coating of wood, metals, plaster, and other substances, which are required to be preserved from decay, which composition may also be employed as a pigment or a paint."—(Communication.)—9th.

Thomas Deakin, Balsall Heath, Worcestershire, Esq.,—"Certain improvements in rolling metals, and in the manufacture of metal tubes, also in apparatus and machinery in connection therewith."—11th.

John George Taylor, London, merchant,—"Certain improvements in dress and other pins, and in other dress fastenings and ornaments."—11th.

Robert Olddiss Bancks, of the firm of Bancks, Brothers, Weirhouse Mill, Chesham, Bucks, paper and card makers,—"Improvements in the manufacture of paper."—13th.

George Edward Dering, Lockleys, Hants, Esq.,—"Improvements in the means of, and apparatus for, communicating intelligence by electricity."—17th.

John Ransom St. John, New York, United States of America, engineer,—"Improvements in the construction of compasses, and apparatus for ascertaining and regulating the velocity of ships or vessels through the water."—18th.

Charles Hanson, and Charles Saunderson, London, engineers,—"Improvements in propelling."—18th.

James Mather the younger, Crow Oaks, Pilkington, Lancashire, bleacher, and Thomas Edmeston, of the same place, calenderman,—"Certain improvements in machinery or apparatus for scouring, finishing, and stretching cotton and other woven fabrics."—20th.

Edward Dunn, New York, now residing in the London Coffeehouse, London, master mariner,—"Improved engine for producing motive power by the dilatation or expansion of certain fluids or gases by the application of caloric."—20th.

IRISH PATENTS.

Sealed from 21st November, to 19th December, 1850.

Christopher Cross, Farnworth, near Bolton, Lancashire, cotton spinner and manufacturer,—"Improvements in the manufacture of textile fabrics, also in the manufacture of wearing apparel and other articles from textile materials, and in the machinery or apparatus for effecting the same."—November 21st.

Peter Armand Le Comte de Fontainemoreau, 4 South-street, Finsbury, London, and also 24 Boulevart Poissonnee, Paris, France, patent agent for inventions.—"Certain improvements in oscillating engines."—December 7th.

William Radley, chemical engineer, and Frederick Meyer, oil merchant, both of Lambeth, Surrey,—"Improvements in treating fatty, oleaginous, resinous, bituminous, and cerous bodies, in the manufacture and application of them, and of their compounds and subsidiary products, together with the apparatus to be employed therein, to new and other useful purposes."—7th.

Lucien Vidie, 14 Rue du Grand Chantier, Paris, in the Republic of France, French advocate,—"Certain improvements in measuring the pressure of air, steam, gas, and liquids."—14th.

Francis Edward Colegrave, Brighton, Sussex,—"Improvements in the valves of steam and other engines, in causing the driving wheels of locomotive engines to bite the rails; and also in applying water to steam boilers."—14th.

Joseph Findlay, New Sneddon-street, Paisley, Renfrewshire, North Britain, manufacturer,—"Improvements in machinery or apparatus for turning, cutting, shaping, or reduciug wood or other substances."—19th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 20th November, to 16th December, 1850.

Nov. 20th,	No. 2543.	Joseph Last, Haymarket,—"The Continental wardrobe portmanteau."
—	2544.	Joseph Walker Smith, Birmingham,—"Button."
21st,	2545.	John Allen, Clarence-place, Hackney-road,—"Rocking-horse."
—	2546.	G. H. and G. Nicoll, Dundee,—"Portable family mangle."
—	2547.	W. and C. Middleton, Long-acre,—"Centripetal wheel-plate."
—	2548.	Francis Cranmer Penrose, Trafalgar-square,—"The Helicograph, or logarithmic spiral compass."
22d,	2549.	George Smith, Castle-street, Liverpool,—"Waistcoat having a buoyant lining."
—	2550.	Deane, Dray, and Deane, King William-street, London-bridge,—"Improved stove."
23d,	2551.	Charles Boardman, Pond-street, Sheffield,—"Cover for cruet or spirit frame."
—	2552.	Ross and Sons, Bishopgate-street,—"Shield for a comb."
25th,	2553.	Burgess and Key, Newgate-street,—"Grater."
—	2554.	William Riddle, East Temple Chambers, Whitefriars,—"Latch and bolt union."
27th,	2555.	William Stidolph, Bath,—"The chiragon, for teaching and enabling the blind to write."
28th,	2556.	Thomas Dismore and Son, Clerkenwell-green,—"Spring-holt."
—	2557.	William Southam, Nuncaton,—"Self-acting millstone ventilator."
—	2558.	Joseph James Galt, Portsmouth,—"Cape."
—	2559.	Lincoln and Bennett, Sackville-street, Piccadilly,—"Ventilating hunting cap."
29th,	2560.	Solomon Solomon, Commercial-place, City-road,—"Marine balance time-keeper."
—	2561.	Jacob Parker, Montpellier-avenue, Cheltenham,—"Lady's railway portmanteau."
—	2562.	Joseph Horatio Cutler, Birmingham,—"Button."
—	2563.	Richard and Henry Williams, Ludgate-hill,—"Self-opening parasol."
30th,	2564.	John Whitehead, Charlestown, Pendleton,—"Valve box and valves for the supply-pipes of steam-engines."
—	2565.	Thomas Oldham, Manchester,—"Shirt."
Dec. 2d,	2566.	John Baily, Mount-street, Grosvenor-square,—"Pheasant, poultry, and cattle fountain."
—	2567.	Peter Rigby, Grove-street, Liverpool,—"Apparatus for burning spirits for the purpose of obtaining heat for portable cooking apparatus."
—	2568.	Alfred Clayton, Lymington, Hants, gun-maker,—"Tube for Colonel Hawker's new ignition."
3d,	2569.	George Twigg, Birmingham,—"Dress fastener."
—	2570.	Thomas Oldham, Manchester,—"Shirt front."
—	2571.	Hargrave, Harrison, & Co., Wood-street, Cheapside,—"Parasol."
5th,	2572.	J. W. M. Last, Strand,—"Improved printing machine."
6th,	2573.	Charles Warner, Birmingham,—"Penholder."
—	2574.	William Langford, Hitchin,—"Gas stove."
—	2575.	Richard Batt and Sons, Edward-street, Portman-square,—"Vesicolor trousers."
9th,	2576.	William Marshall, Regent-street,—"Shirt."
—	2577.	George Barnett, Jewin-street,—"Magical cylinder strop."
—	2578.	Ransomes and May, Ipswich,—"Parts of a water crane for railways."
10th,	2579.	E. R. Turner and Co., Ipswich,—"Roller mill."
11th,	2580.	G. Turton, Wolverhampton,—"Flooring cramp."
—	2581.	Walker Brothers, White Lion-street,—"Utrolibet carriage."
—	2582.	Francis Cranmer Penrose, and George Forrester Bennett, Trafalgar-square,—"Sliding helicograph."
13th,	2583.	R. and J. Rankin, Liverpool,—"Parts of machinery for cleansing grain or seeds."
—	2584.	Abraham Dimoline, Bristol,—"Compensation pianoforte mechanism."
14th,	2585.	Luke Brierley, Birmingham, and Thomas Beech, Shelton,—"Vertical revolving disc signal lamp."
16th,	2586.	Thomas De La Rue and Co., Bunhill-row,—"Edges of envelopes."

TO READERS AND CORRESPONDENTS.

ENQUIRER, Glasgow.—The question is a very important one, and cannot be answered in the limited space available here. If our correspondent will direct his inquiries to the Office for Patents, 166 Buchanan Street, he will learn all that is satisfactorily decided in reference to it.

R. S.—We have found it impossible to make use of his communication this month.

J. W., London.—The diagrams and remarks having already been before the public under so many forms, we find it impossible to accede to his request.

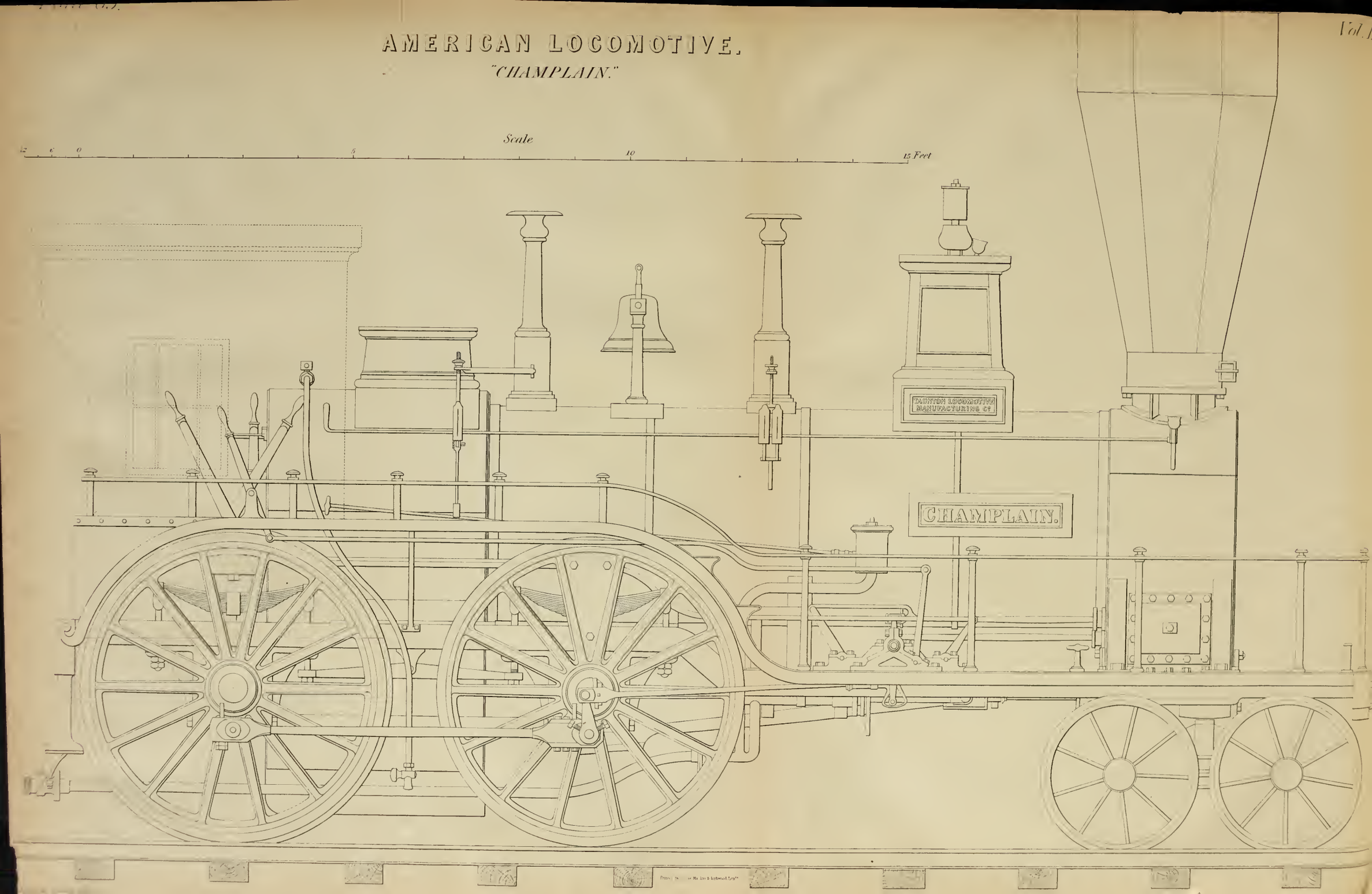
J. W. & Co.—The same remark applies in this case. The invention has been illustrated elsewhere more than once.

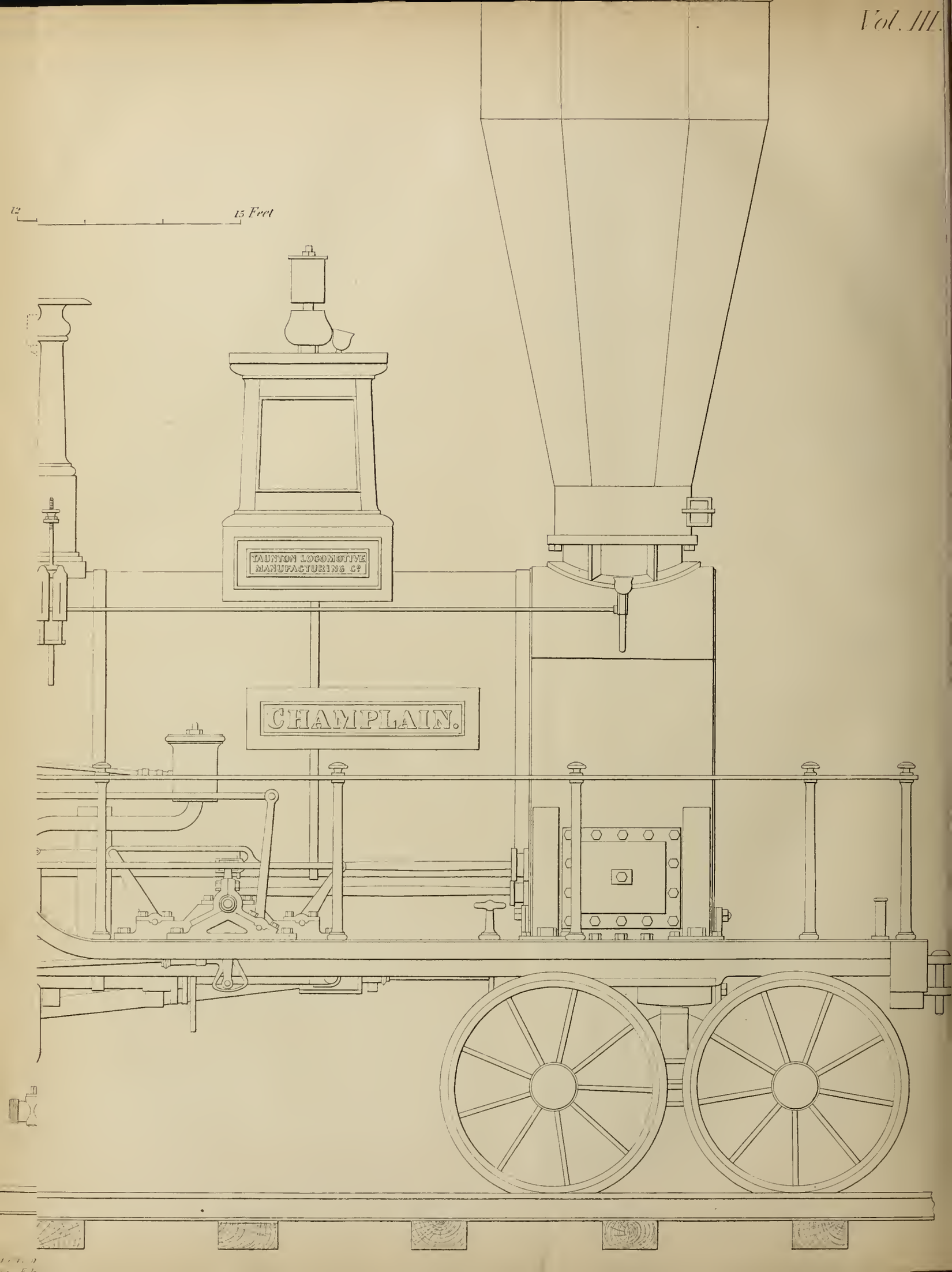
P. M., Tranent.—We retain his communication for use next month.

R. B.—We expected to have heard from him.

AMERICAN LOCOMOTIVE.

"CHAMPLAIN."




12
15 Feet
TAUNTON LOCOMOTIVE MANUFACTURING Co.
CHAMPLAIN.

AMERICAN ENGINEERING.—LOCOMOTIVES.

Illustrated by Plate 65.

In illustration of our former remarks on the American locomotive, we now present to the readers of this Journal the accompanying drawing of one on the Hudson River Railroad.* This road was made under peculiar circumstances, which rendered necessary a construction of engine differing somewhat from that usually employed here, for they had to combine both power and speed, whereas, on the older lines, power alone was requisite, their rate of speed being, according to English notions, but low. The speed on most lines in this country varies from twenty to thirty miles an hour, and on one or two lines, only the express trains, running in connection with mail steamers, run at thirty-five miles of running speed, for instance, on the Western road.

The Hudson River Railroad extends from New York to Albany. This direction being the great high road from the city to the north and west, an immense amount of passenger and freight tariff constantly passes along it. The magnificent Hudson River was the main, almost the only thoroughfare, till the railroad was started, and, to supply the demand, its waters are constantly covered with countless steamboats and sailing vessels of all sizes. Albany is situated 150 miles up the river, beyond the city of New York, and the river is large enough for steamers of 1,500 to 1,800 tons burthen, a great number of which are daily and nightly passing to and fro. Drawings of the powerful engines of the latest and most magnificent of these boats, the "New World," have been recently given in the new edition of Tredgold. These boats have berths for 500 or 600 passengers, and are fitted up with a luxurious elegance, which, to the non-travelling English public, was incredible, till the arrival of the "Atlantic" and "Pacific" steamers in Liverpool. Still, in magnificence, the river boats, not only from the nature of their passages,—free from sea-sickness, the hazards of storms, and the consequent inconveniences thereof, and impelled by vast competition,—will always outstrip sea-going steamers. The competition between various companies had reduced the fare to the lowest standard of profit, while it kept increasing the necessity for extravagance in the outfit, and in keeping up high speeds, to allure the public. To start a railroad in opposition, running side by side with the boats, and along the same towns and villages, was a hazardous undertaking. The usual speed on railroads was not so much greater as to entice the passengers to leave the magnificent "floating palaces" for a mode of travelling which, besides the inconvenience of dusty roads, is, as far as pleasure travelling goes, certainly not a comfortable one. Great speed must therefore be determined on. But another question had to be decided. Railroads have nowhere proved that gold mine to the shareholders they were once thought to be; and, above all the experience of the old world had long since shown, that an increase of speed increased the expenses in a greater ratio than the receipts. Steamboat conveyance is always cheaper than the same quality by railroads. To meet the opposition of the boats, therefore, the Hudson River Road would have to take extreme lowness of fare, besides high speeds, for its standard. The competition between the boats themselves had reduced the profits to a low ebb; but when a new competitor started into the field, it was probable they would cut down their own profits still more, not to lose their chance altogether. Low fares and quick travelling, each of them separately, are easy of attainment; but the combination of these two antagonistic principles formed the difficulty under which the Hudson River Railroad started into life, and against which it has so far successfully combated. The penny-wise and pound-foolish economy, which has injured so many roads, had to be eschewed from the outset, to ensure the stability of the enterprise. The highest engineering talent which the country afforded, was called into service. The most solid and perfect construction—the one least liable to derangement, was adopted everywhere. With the aid of these, and untiring zeal and energy—the president and directors were enabled to carry on the construction of the greatest and most important of the iron roads in the United States, against difficulties which no other had to compete with.

It is for this reason, apart from any other consideration, that we looked to the locomotives of America, when we thought of placing an example before an English public. We have praised the American engines, and must expect that the sample we bring will be diligently, perhaps invidiously, compared with English engines, and must therefore be prepared with sufficient and positive or authentic proofs of the excellence of the engine. General praise is of no use where facts are to be compared with facts.

The Hudson River Railroad is at present, and since the beginning of the year, open for daily traffic to Poughkeepsie, seventy-five miles from New York, about half the entire distance. Running the whole distance along the river—in fact the greater part is protected by a river wall—it is on the average tolerably level; there are some steep, but only short grades; but it is crooked, with many quick and serpentine curves. Throughout the past summer and spring, the freight traffic has been very limited; but in winter, when the river is closed, it will be as great. In summer, the road tariff for the kind of merchandise transported here, caused all freight to be absorbed by the "cold water system;" but the passenger traffic has been immense.

There are twelve stopping places between here and Poughkeepsie. The engines take the cars only to the Thirty-first-street station in New York, the remaining three miles being entirely through the streets of the city; the cars are drawn to the terminus by horses, a city track being laid. It is in contemplation to build peculiar engines for this purpose; and one, a condensing locomotive, has already been successfully tried. The seventy-two miles are run by the express trains in 2 hours 25 minutes, and by the remaining trains in 2 hours 45 minutes. Allowing about 36 minutes for stoppages, and a very slight loss of time due to slackening speed on approaching, and getting up speed on leaving stations, we have an average running speed of 44.5 miles per hour. This is the *average* throughout the whole line. Every engineer will know, that owing to inclines, curves, the state of rails, one minute's extra detention at a station, &c., this average can scarcely be maintained through two-thirds, hardly one-half the length, and the *actual* speed for a great part of the line is above 50 miles an hour. The road is the usual narrow guage.

The engines used are of various constructions, mostly coupled engines, with 5½ feet drivers. There are two engines with 6 feet single drivers. Two engines have outside cylinders, the others inside. A year's experience has shown the propriety of larger drivers; and the new engines, as designed by the company's engineer, Mr. M'Queen, before mentioned, will have 6½ feet coupled drivers. These will be the first engines with outside cylinders ever designed purposely for express trains. The accompanying drawing, Plate 65, represents the inside cylinder engine "Champlain," one of the best now on the road. She is worthy to be placed by the side of the best English engines, both as to mechanical construction, the duty she has performed, and the elegance of her general design. We present a side elevation of the engine, to be followed by such sections and details as are necessary to explain her working gear. All the dimensions are from our own measurements; the statements of her performances are taken partly from personal observation of her action, and partly from the daily register and books of the machine-shop, and we can therefore vouch for the accuracy of the details. Her main dimensions are—

Cylinders, 15 inch bore, 20 inch stroke.

Driving-wheels, 5 feet 6 inch diameter, coupled, their springs connected by an equalizing beam.

Inside firebox, 3 feet 5½ inches long, 3 feet 3⅜ inches wide, height from surface grate to crown sheet, 5 feet ⅝ inches.

* See pages 217 and 243, Vol. II., and page 30, Vol. III., *P. M. Journal.*

Water space between inside and outside firebox, 2 inches.
Barrel of boiler, 42 inches inside diameter.
Top of exhaust pipe, $2\frac{3}{8}$ inches in diameter.
Flues, 144 in number, 2 inch outside diameter, 11 feet 3 inches long.
Grate surface,..... 11.34 square feet.
Direct (firebox) heating surface,..... 79.43 „
Indirect (flue) heating surface,..... 836.8 „

Total heating surface,.....916.23 „

Distance from crank-axle to centre of cylinder and smokebox, 10 feet $4\frac{3}{4}$ inches.

Distance from crank-axle to centre of truck, 11 feet 2 inches.

Distance between the centres of the two driving axles, 6 feet $3\frac{1}{2}$ inches.

The truck-wheels here shown are Whitney's patent cast-iron corrugated plate wheels, and are 2 feet 8 inches diameter.

The total length of engine, exclusive of cattle-fender, made of flat-iron, is 24 feet; height of top of smoke-pipe above rails, 15 feet.

The frame consists of two plates of iron, with a square bar riveted between them. The jaws for the driving axle-boxes are of cast-iron, the top rib fitting between the two plates of the frame, and riveted to them. Below the axle-boxes, the two jaws of the two axles are connected by a $1\frac{1}{4}$ inch bolt, passing through a cast-iron thimble, fitted in between them. At the front of the forward jaw this bolt takes hold of a brace, which goes up to the frame at the lower part of the bend, where it is also riveted between the two frame-plates. This forms a simple and very strong frame. The construction will be better understood from the longitudinal and transverse sections. The depth of the plates is 5 inches; their thickness, $\frac{5}{8}$ inch; the whole breadth, $3\frac{1}{4}$ inches. Each jaw is furnished with a wedge, which can be screwed, to take up any play arising on the axle-box through wear. The connection between the engine and tender is formed in the common fashion of American engines, —by a stiff crowbar, a wedge or friction-lever being placed between the two, to take up the loss by wear in the pins.

Each cylinder has two valves in the same steam-chest; the upper, or cut-off valve, moves on a fixed, perforated plate immediately over the main valve. The former is worked as seen in the external elevation, from a return crank on the crank-pin. The main valve is worked from eccentrics; the motion used is the v hook.

The tender is carried on two 4-wheeled trucks. The tank holds 1,500 gallons.

The weight of the engine, in complete working order, is 21 tons 3 cwt. nearly, which is thus distributed:—Weight on the two driving-axles, 30,060 lbs.; on the truck, 17,300 lbs.; total, 47,360 lbs. By reason of the equalizing beam, the same weight is constantly retained on each driving-wheel, into whatever position the inequalities of rail surface may throw the engine. The pumps are worked from the crosshead. Each has two air chambers. The timber-house on the platform, for the protection of the engineer and fireman against the inclemencies of the weather, is only dotted in—to show the reversing levers. It forms, with the footboard running all round the engine, a *sine quâ non* detail of every American engine. It has a door in front on each side, opening on the footboard, and is amply furnished with windows both at the sides and in front. A bell is hung on every engine in this country, besides the whistle, to give warning on the approach to stations or cross roads.

This engine is furnished with every arrangement which can improve her action and her looks. The boiler is covered with lagging and Russia sheet-iron, bound in the usual manner with brass hoops. The footboard is carried on the outside by an angle iron, the front edge of which is polished throughout the entire length. There is altogether a great deal of bright work about her, giving her an exceedingly light and elegant appearance.

The following account of the running duty of this engine, since first put on the line, will prove the great regularity with which she has worked. Her ordinary duty is a double trip over the road per day, Sundays excepted, when no trains are run. When she first commenced, the road was open from New York to New Hamburgh, being a run of 63 miles, or 126 miles per day. On the 31st December, 1849, the road was opened through to Poughkeepsie. The "Champlain" was brought on the road on the 13th December, 1849, and made her first trip with a passenger train on the 15th.

Number of miles run in	December	1,729
" " "	January (1850),	3,240
" " "	February	2,448
" " "	March	2,680
" " "	April	3,744
" " "	May	3,528
" " "	June	3,096
" " "	July	2,578
" " "	August	3,888
" " "	September	2,448
Total in nine months		29,379 miles.

When laid up in July for ten days, it was to receive a new tire, and to have her wheels turned up. Her valves were also altered, and changed for brass slides, cast-iron having been previously used.

In a succeeding paper we shall give some additional particulars relative to her work, the usual weight of the trains, and her consumption of fuel.

New York, 1850.

WINDS AND ATMOSPHERICAL ELECTRICITY.

If the density of the atmosphere were invariable, its quiescence would remain undisturbed, and it would never be found in motion. But numerous causes are every instant at work to effect changes in its density. The most important of these causes is the heat of the sun, which raises its temperature, and thereby occasions it to expand. It thus becomes lighter, yields up its place to air which is colder, and therefore denser, in obedience to the laws regulating the equilibrium of fluid bodies, and thus gives rise to those aerial currents termed winds. The principal part of the heat received by the atmosphere is not obtained directly from the sun, but by radiation from the earth; hence the lower strata of air are warmed sooner than those above, and consequently an ascending current is produced. Now, it is in the equatorial regions that the earth receives most heat, and therefore it is here that motion may be said to begin, and where it goes on with most constancy. Whilst the heated air ascends, and spreads itself out in the upper region of the atmosphere, there to undergo refrigeration and condensation, a cold current sets from each pole towards the equator, where it undergoes, in its turn, the process of rarefaction. In this way a grand circulation is constantly kept up.

Trade Winds.—Over the open seas, to the distance of 30° on each side of the equator, there are constant winds, which, in the north hemisphere, blow from north-east to south-west, and in the south hemisphere, from south-west to north-east. On approaching the line their force diminishes, so that, though blowing towards each other, they do not meet. They are separated by a tract, called the region of calms, or variables, 4 or 5 degrees in breadth, where a thick foggy atmosphere prevails, and where there are frequent rains of short duration, attended by thunder and lightning, whilst the region of the trade winds is remarkable for serene weather. The limits of the trade winds vary with the seasons, to the extent of 6 or 7 degrees; they are not found in the neighbourhood of continents. The trade winds of the Atlantic have more regularity than those of the Pacific. An explanation of these winds may be found in what has been previously said as to the currents of cold air which set from the poles towards the equator. Their easterly and westerly directions are given in this way: the rotation of the earth is least at the poles, and greatest at the equator. As the north current proceeds southward, it comes into contact with parts of the globe which are moving more rapidly from west to east than itself, and from which, though it derives an additional motion in the same direction, it never, during all its progress, acquires the same amount. Consequently the earth moves on faster than the current which is left behind; and the effect to a person in that region is as if the wind blew from north-east to south-west, gradually changing into a direct easterly course on nearing the region of calms. In the same manner, the wind from the south pole blows from south-east to north-west, gradually changing into a direct westerly course.

Whilst these winds are blowing along the surface of the earth, there are currents moving in an opposite direction through the upper region of the atmosphere. This was proved when the volcano in the island of St. Vincent ejected ashes, which were carried to the island of Barbadoes by an upper current blowing in a direction exactly opposite to that of the trade wind below. In like manner, ashes from the volcano of Cosiguina, in Central America, have been blown to Jamaica, whilst the trade wind was moving the other way. Stizelechi, on ascending the volcanic mountain of Kiranea, in Owhyhee, at an elevation of 4000 feet, found himself above the trade wind, and exposed to a wind blowing in a direction opposite to that below. This wind had a different hygrometric and thermometric condition. When he had reached the height of 6000 feet, a current of air was found blowing at right angles to the direction of both the currents beneath. This current again differed in its hygrometric and thermometric conditions from the others; it was warmer than the one next to it. To the contact of these counter currents may be traced variations of atmospheric temperature and pressure, precipitations of moisture, and the formation of clouds. The south-west upper current, just spoken of, descends again about the parallel of 30° N. lat., and forms the wind which favours ships sailing from North America to Europe. The average time, during a period of six years, occupied by a voyage from New York to Liverpool, was 23 days, whilst the return voyage occupied 40 days. Along the line of contact of this wind and the trade wind, there are frequent calms, variables, and squalls. This current makes itself felt in Europe, and occasions the predominance of south-westerly winds in that quarter. North-westerly winds prevail in the corresponding latitude of the other hemisphere.

Monsoons (from *mooseen*, a Malay word signifying season)—are modifications of the trade winds produced by masses of land. They occur in the Arabian Gulf, the Indian Ocean, and the Chinese Sea. They are periodical winds, blowing from April to October, from south-west to north-east, and in an opposite direction during the other six months of the year. They have never yet been satisfactorily accounted for; but the usual explanation is to say, that a rarefaction of the air is produced on the table land of Asia by the heat of the sun, when that body has a northern declination; the air therefore flows into that quarter from the colder region near the equator. Hence the south-west monsoon. The table land of South Africa being heated by the sun when he has a southern declination, produces a similar rarefaction, and the north-east monsoon is produced. At the time the sun passes the equator, and a change from one monsoon to the other is about to take place, the winds are variable, and thunder-storms occur. In summer, the sun acting upon the Sahara desert is the cause of a wind blowing from the north; in winter, the wind has an opposite direction, in consequence of the stony plain radiating, and therefore cooling, more rapidly than the sea.

Land and Sea Breezes—are of daily occurrence off the coasts and islands of warm countries. During the day the land becomes warmer than the sea, and hence the air resting upon it rarefies more rapidly than that over the sea. It ascends, therefore, and its place is supplied by the cooler air of the sea. At night, the land having a greater radiating power than the sea, the air in contact with it sinks in temperature at a quicker rate than that resting on the sea. It is now the warm sea air that ascends, and a current sets in from the land to occupy its place. In the morning and evening, when the temperatures of sea and land are about the same, no breeze is perceptible.

Winds of Europe.—The winds of these latitudes appear to blow with so much irregularity, that before a large body of observations has been made and sifted, it would be futile to put forward any theory. It has been noticed, however, that in winter the direction of the wind is more meridional than at other seasons; that easterly winds prevail in March and April; that in summer the winds blow mainly from the west, and turn often to the north; and that in autumn southerly winds predominate, especially in October.

For six weeks during the summer, there is a wind that has received the name of Etesian, which blows in the day-time from north-east to south-west, over the countries bordering the Mediterranean.

Storms.—Before the occurrence of a great storm, the air is frequently of a dead stillness, the sky of a pale blue, and there is a sensation of suffocating heat, although the thermometer does not indicate a very elevated temperature. Cumulose clouds rise at every point of the horizon, swell, and unite. Thick cumulo strati seem to join them to the earth, whilst light cirri cover the sky. The altitude of storm-clouds varies considerably. In tropical regions, especially in the region of calms, storms rage with great violence; they are accompanied by hurricanes, which cause terrible destruction to life and property. In the higher latitudes, storms are less violent, and are unequally distributed through the seasons, a great majority occurring in summer. Storms are common in the north of Italy, and in Greece. In Sicily they are less frequent; in high northern latitudes very rare. European storms are usually brought by the south-westerly winds; but they often owe their origin in winter to the struggle between the east and west winds.

Hurricanes, tornados, whirlwinds, are violent tempests, in which the wind revolves round an axis, one end touching the earth, the other either vertically above or slightly inclined forwards. The region chiefly afflicted with them in the Atlantic lies to the east of the West India Islands, between June and October; they begin near the Caribbees, and move in a north-westerly direction towards Florida, and then, turning at the tropic of Cancer, take a south-westerly path. In the Pacific, they rage between December and April, commencing to the north-east of Madagascar; they direct their course, in the first instance, towards that island, and then, at the tropic of Capricorn, tend from north-west to south-east, so that their paths in the two hemispheres tend towards the poles, and take opposite directions. What is termed the law of storms consists in this:—1st, That in hurricanes and in the severer storms occurring in low latitudes, the wind has two motions. It blows in a more or less circular manner, round a focus or centre; and it also blows forward, so that, like a point in the rim of a rolling wheel, it is turning round and moving onwards at the same time. 2d, The wind of a storm occurring on the north of the equator, rotates from east to west (a direction opposite to that of the hands of a watch), and when occurring on the south of the equator, it turns from west to east, that is, in the same direction as the hands of a watch. The most dangerous part of a hurricane is near its centre, and it is said that, if a vessel has sea-room, it is better to sail on a circular course along with the wind, instead of upon a straight one through the hurricane. If a mariner can acquire a knowledge of his position in the whirlwind, he may, by lying-to, allow it to pass him, or, by sailing towards its outskirts, get into a less violent part, or escape it altogether. This subject has excited much attention of late, in consequence of its importance to the mariner, and much credit is due to Colonel Capper, Colonel Reid, Dr. Thom, Messrs. Redfield and Piddington, who have severally devoted themselves to its investigation.

The Atlantic hurricanes move in a direct course, at the rate of from 15 to 43 miles an hour, and can sometimes be traced over a path more than 3,000 miles long. The great storm of August, 1830, which was first noticed off the Windward Islands, and crossed the Bank of Newfoundland seven days afterwards, having advanced at the rate of 18 miles an hour. The velocity of the wind in its rotatory course was much greater than this, probably 90 miles an hour. The diameter of these circular storms is sometimes as much as 700 or 800 miles; the height varies from 1 to 5 miles, and there is a calm place in the centre, varying in breadth from 5 to 30 miles. In this place the water is often raised 2 feet above its ordinary level. This is owing to the diminished pressure of the atmosphere at that spot. The sea, indeed, rises from the same cause within the whole circle of the storm, but not to the same amount. Consequently, when the hurricane approaches land, a huge wave is sent on shore possessing overwhelming force. Sometimes two hurricanes come into collision, in which case the certain destruction of any object which happens to be at the point of meeting is involved. A mountain has been known to separate a hurricane into two parts, each afterwards pursuing its own path.

Hurricanes, called Typhoons (*tae foong*, great wind), which blow from the south and east, and usually last twenty-four hours, sweep the coast of South China with great violence during summer. In the Straits of Malacca, short but violent gales, called *arched squalls*, occur. Violent storms, called *pamperos*, suddenly sweep across the Pampas during summer. The wind seems to come down from the snowy summits of the Andes, and in its progress to the east coast usually collects thick clouds of dust. Over the great plains of New South Wales, in dry weather, upright columns of dust are sometimes seen moving one after another under the influence of the wind, and preserving a nearly uniform diameter throughout their whole length. Their lower ends seem to touch the ground, whilst their tops insensibly vanish from the sight. They are about 70 to 100 feet high, and 20 feet broad. They move swiftly along, but do no damage.

Local Winds.—Cold winds: In Dalmatia there is a north wind, called *Bora;* another in Spain, called *Gallego*. The *Bise* is a north-west wind, that blows along the valley of the Rhone; the *Mistral* is a south wind, experienced in the south of France; the *Harmattan* is a cold, dry, and parching wind, that blows in Africa and some of the countries of the east. Hot winds: The *Simoon*, a burning and pestilential wind of Persia and Arabia, comes, loaded with hot sand, from the Sahara desert; its temperature is often 123° Fahr. In Louisiana, Chili, and in the great plains near the Oronoko, as well as in New Holland, the ground winds are very hot. The *Sirocco* of Italy is a hot, moist, and relaxing wind, blowing from Africa; the *Solano* is a similar wind, experienced in the south of Spain; the *Leste* is a hot and very dry wind, felt at Madeira

and Teneriffe. It comes from Africa, and occasionally brings with it impalpable dust from that continent.

Velocity of Winds.—Various instruments have been invented for the purpose of ascertaining and registering the velocity, force, and direction of the wind—points of much importance in meteorology. Of these, the one most generally used is Osler's Anemometer. The pressure of the wind may be calculated from the velocity, since it has been found that it increases as the square of the wind's velocity, as will be seen from the following table:—

	Velocity in miles per hour.	Pressure on a square foot.
Gentle breeze,	3·25	0.83 oz.
Pleasant breeze,	6·5	3·33 oz.
High wind,	16·25	1 lb. 5 oz.
Storm or gale,	32·5	5 lbs. 3 oz.
Great storm,	56·29	15 lbs. 9 oz.
Hurricane,	79.61	31 lbs. 3 oz.
Violent hurricane,	97·5	46 lbs. 12 oz.

The tempest of November 29, 1836, one of the most violent on record, was at London at 10 a.m., at the Hague at 1 p.m., at Linden at 4 p.m., at Hamburgh at 6 p.m., and at Stettin at 9½ p.m.

atmospherical electricity.

The electricity of the atmosphere is among its most important meteorological phenomena, and it is much to be lamented that no regular and simultaneous observations have been hitherto made with regard to it, at the numerous stations now established for the investigation of terrestrial phenomena. Some valuable observations, however, have been made at the Kew Observatory, for the British Association, and by M. Quetelet, at Brussels.

The electricity of the air is either dynamic or static. The former is electricity in its current condition, such as we see in thunder-storms. The latter involves a subject of much higher philosophical interest, viz., the amount of electricity which is resident in the air at any given moment, at any given place. The chief instrument of observation is the induction electrometer, invented by M. Pettier. It is used to ascertain by induction, at a given and elevated point, the quantity of electricity in the atmosphere. The process is a very simple one. A metallic ball-electrometer is raised, touched, and lowered, and the quantity of electricity it has obtained is then examined.

It appears that fluctuations in the electricity of the atmosphere produce two maxima and minima of electricity in the course of twenty-four hours, as is the case with other meteorological phenomena. The atmosphere is nearly always positively electric. In the course of five years, but twenty-five instances of the contrary occurred to M. Quetelet, and these happened either immediately before, or immediately after, rain or a storm. The earth, on the other hand, is almost always negatively electric. The principal maximum occurs in the forenoon, and the second at night. The hours vary with the seasons, the two minima falling between the two maxima: the mean annual maxima at Brussels occur at 8 a.m. and 9 p.m. Fogs, rain, hail, sleet, and snow, effect such disturbances as show that they are intimately connected with electricity. Under their influence, the instruments indicate rapid alternations of positive and negative electricity. Clouds have a similar effect, and they produce sparks from the insulated conductor in quick succession. The electricity of snow or fog is double that of rain, and equal to the mean maximum of the cold months. It is strongly developed during the deposit of dew. Grey clouds are said to have negative—red, white, and orange clouds, positive—electricity. The meeting of clouds differently charged produces an explosion. Probably the friction of clouds and currents moving in different directions, always develops more or less electricity. It is greater in winter than in summer; greater at the poles than at the equator. It increases directly with the distance from the earth's surface, and is always greatest when the sky is clear. There appears to be some connection between the electrical state of the air and the direction of the wind.

Thunder and Lightning.—The appearance of lightning is the consequence of great local disturbance, and yet it is remarkable that such disturbances take place when the amount of atmospheric electricity is very small. Lightning is a flash which passes a quantity of electricity with inconceivable velocity, from the clouds to the earth, or from one cloud to another; probably, also, from the earth to the clouds. The flashes usually have the appearance of a zig-zag line, sometimes forked at the extremity. Other flashes seem to cover a large part of the sky, near the horizon; this kind is called sheet lightning. Others again, under the form of round luminous balls, cross the sky for some distance, so that they are in sight for a few seconds, whilst the zig-zag kind only lasts for the 1000th part of a second. Lightning emanates from the upper surface of a cloud, as well as from the lower. A chapel, situate on the summit of Mount St. Ursula, in Syria, was struck by a flash from a cloud half-way down the mountain.

Since light travels much faster than sound, some seconds elapse between the flash and the time of hearing the thunder. That interval will be in proportion to the distance of the spectator from the cloud. Reckoning 1120 feet for every second, we may calculate the distance pretty accurately. Sometimes there are repeated flashes of lightning, unaccompanied by thunder. It is said that the sheet lightning, seen sometimes on warm summer evenings, is only the reflection of distant flashes, taking place below the horizon. After lightning a sulphurous smell is often perceptible, which arises from the nitric acid chemically formed from the oxygen and nitrogen of the air, by the passage of the spark. Thunder-clouds are stationed at very different heights. They have been measured at a height of 251,000 feet, but they are usually placed between 3000 and 5000 feet from the ground.

In its passage to the ground, lightning passes along the object that will best act as a conductor. It melts metallic bodies, vitrifies the surface of fusible rocks, and, when it falls upon a bed of sand, it forms tubes out of the particles, sometimes several feet long. These have received the name of fulgurites. Combustible bodies are set on fire by it, and its force is so great that it often removes heavy bodies to some distance. If it comes in contact with a magnetic needle, it reverses the poles, and diminishes, sometimes destroys, the magnetic power. On the other hand, iron becomes magnetic after being struck by it. Flames have been seen during storms at the surface of the land or water. The luminous appearance seen to play sometimes on the masts of vessels, to which sailors give the name of the Fire of St. Elmo, is a phenomenon of electricity. Columbus records that, on a certain night during one of his voyages, "St. Elmo appeared on the top-gallant masts with seven lighted tapers."

Thunder-storms are of rare occurrence in high latitudes. Scoresby only heard thunder twice, in the course of numerous voyages, north of the 65th parallel. A person who resided many years near North Cape had only seen one storm. In some tropical countries thunder is never heard. This is the case at Lima. At Cairo storms are uncommon, whilst in Jamaica they are of almost daily occurrence, from November to April.

Hail—is a frequent accompaniment of storms. It consists of suddenly condensed vapour frozen in the higher regions of the atmosphere. It is usually of a small size; but pellets, weighing 4 or 5 ounces, are not uncommon, and occasionally balls are reported to have fallen weighing several pounds. Such statements, however, are to be listened to with suspicion, the explanation probably being that two or more pieces became united on the ground. However, it is stated, on good authority, that, in India, hailstones of the extraordinary weight of 14 pounds have fallen. They had a rough external coat, round a nucleus of clear ice, having a peculiar radiated structure. A hail-storm seldom lasts very long, and its effect is generally confined to a narrow strip of country. It is during the greatest heat of the day that hail usually falls; it rarely occurs at night. In Great Britain and France most hail falls in spring and in winter, whilst in Germany and Russia its season is summer. It falls more frequently upon plains than on mountains. Some places are seldom troubled with it, whilst others suffer severely every year. This scourge is rare within the tropics, except amongst the mountains. It fell to such a degree at Mexico, in August, 1830, that horses were up to the knees in it in the street. It is often formed during a contest between a north and a south wind: the temperature of the lower region of the atmosphere is then very high; but it decreases rapidly with the height, and sinks towards zero in some zones below that of the storm clouds. It has been noticed, that when hail falls, there are always two clouds, one below the other. It is probable that the balls are composed of a nucleus of frozen snow, enlarged by the watery vapour of the inferior cloud condensed and frozen on its exterior.

Water-spouts—consist of a column of water caught up by a whirlwind, and connecting the clouds with the sea or the waters of a lake. When they burst, the place beneath, if on land, suffers much damage. It is the opinion of some that they are formed by a condensation of atmospheric vapour, set in motion by a rotating wind, and descending towards the water, which ascends in a pointed spiral until a junction is formed, the whole having the appearance of two cones, one of which is inverted. The phenomenon is strongly suspected to arise from the operation of electrical attraction.

ENGINEERS AND THEIR WRITINGS.

Our sentiments on the importance of the cultivation of a literature of their own by engineers have already been sufficiently expressed. Since the time that we addressed our readers on this topic—though we dare not flatter ourselves that our own suggestions alone have operated on the

lever which has moved the engineering world,—several specimens of authorship have made their appearance, ushered into the world by the indefatigable Weale, which bid fair to rival, in point of typography, engravings, and editorial management,—the management, bless the critics, not of pretentious publishers, but of competent engineers,—the later publications, we say, bid fair to rival the productions of French and German authors, who hitherto have certainly borne the palm, not only on the Continent, but in England also. Such has been the paucity of our mechanical literature, that, in the course of the reissue of Tredgold's work on the steam-engine, it has been deemed expedient to republish the famous account of the primitive locomotive of Stephenson, at the hazard of being stale, flat, and unprofitable. Ungrammatical specifications, incomplete accounts of observations and experiments, and imperfect or partial deductions, have been examples much more the order of the day, —if we can talk of order where nothing but disorder has prevailed,—than those beautifully lucid, regular, and symmetrical publications which belong peculiarly to the French. And yet, while the French are our masters in professional literature, we have always maintained, and do still hold, a pre-eminence in the application of mechanical principles and their development in practice, which has hitherto left our neighbours little to do but to imitate and learn from us. It is not, therefore, because we have less to communicate, but that we have more to do, when we find ourselves so manifestly inferior in mechanical literature to our continental neighbours; neither can it be urged, that there is less taste for such literature on this side of the channel, for in the few instances in which engineering works have been written in this country, possessing even moderate claims to utility, they have been readily patronized by all classes. The history of Buchanan's Essays on Mill-work furnishes a confirmation of this truth. The earlier editions of this work, vague and insufficient, languished through their first and second thousands; but the succeeding editions, edited by Sir John Rennie, and enriched by some of the practical fruits of experience contributed by Mr. Nasmyth, on the principles of tools,—this edition, deriving vitality from the infusion of a fresh and invigorating spirit, glided into rapid circulation, as an electrified stream of water flows through a capillary tube, which, before the communication of the vital energy, permitted the water to fall only in successive drops, and at measurable intervals.

The new edition of Tredgold's Essay on the Strength of Cast-iron, is another example in point. Published by Mr. Weale, than whom there is no one better qualified for giving a (plausible) reason for the faith that is in him—this work, unsaleable in its original isolated form, has been reissued lately, in two volumes, the first of which pretends to set forth the original work in all its mathematical purity and refinement; and the second of which, published as a continuation by Mr. Hodgkinson, who was retained as editor of the work, contains the whole of the modern theory of the strength of cast-iron, as deduced from the experiments of the editor. By an ordonnance of the publisher, the second volume was unpurchasable, unless the first volume of the work could be produced by the intending purchaser, as a guarantee that the two volumes should float together off his groaning shelves. The consequence was, that the unpractical work of Tredgold, which could not go before, moved off surely and rapidly when associated with the more substantial treatise of Hodgkinson's: like the watch of the cockney in a mob, in the words of the old song—

> "The watch that never went before,
> Went at the coronation.'

With these evidences,—and many other examples might be adduced, —there is plainly encouragement for the production of a new and substantial class of engineering literature. To be successful as a mercantile speculation, it must largely possess a practical character. We have already been abundantly fed with hypotheses, theories, and principles. Weale's Rudimentary Treatises on the Industrial Arts are in the right direction,—they only require to be developed into more comprehensive works, to supply the desiderata which are at present most urgently felt. The subject of railways is one which readily suggests itself as a matter for much and varied investigation; railways are no light matter, when they involve a hundred millions of capital. The uncertainty which still prevails as to the best method of working them, is the best proof of a want of sound and clearly established principles for the guidance of railway mechanists. Great Western "mammoths" *versus* Samuel's and England's "lilliputians," 50 ton locomotives *versus* 10 ton locomotives; bogie-engines *versus* engines with fixed axles; tank-engines, nicknamed "elephant and castle" engines, *versus* engines with separate tenders; inside cylinders *versus* outside cylinders; shallow *versus* deep fire-boxes: gab-motion *versus* link-motion; expansion *versus* no expansion; warranted consumption of coke, 8lbs. per mile, *versus* an unwarrantable consumption of 35lbs.; atmospheric resistance, a very important matter, *versus* air, nothing at all; long, high, wide carriages, on eight wheels, steady, roomy, and light, with glazing by the yard, *versus* short and partitioned carriages on four wheels, "cribbed, cabined, and confined," chilly, leaky, and dark: these, and a multitude of other antagonistic elements, have their co-existence in our railway system. One thing with another, these heterogeneous elements embrace much that goes to constitute all the difference between a flourishing and a ruinous speculation. Some feeble attempts to start a spirit of inquiry and research have been made by the Institution of Mechanical Engineers, but, we fear, with small success; for little has as yet been done, saving some valuable communications by Mr. Buckle, a notice of Sharp, Brothers, and Co.'s famous goods locomotive, illustrated by a magnificent series of plates, some account of Samuel's light engine by the inventor, and some notes of experiments on axles by Mr. M'Connell, in which he concludes that axles ought not, on any account, to have square or abrupt corners about them, a conclusion in which the distinguished vice-president has been forestalled by many a tool-maker. Connected with the reading of these papers, there were, of course, a few rays of the light of experience shed by the members present. The efforts of the body are, however, isolated, and we believe that a more thorough organization of inquiry will be found essential for the successful investigation and establishment of permanent data for railway mechanism. The Institution has a noble duty before it, for never before had railways such need of the application of general principles. It is certain that, whatever may be the efforts of private individuals, locomotive superintendents are the men who, by their position, are best qualified to conduct the necessary investigations. It is true, that by education and ability they are very variously qualified, for locomotive superintendents have been drafted from all classes: some of them have been labourers, some of them gentlemen born; some of them engine-wrights, some of them engine-drivers; some of them derived from the "civil" class of engineers, some of them preciously uncivil. They are divisible into two great classes—the stationary and the progressive, the old school and the new school, the uneducated and the educated, the boorish and the gentlemanly. The former class, it will readily be believed, is that of longest standing, and, with some honourable exceptions, their bigotry and conceit in favour of their own cherished crudities, is equalled only by their contempt for the innovations and improvements of others. With the Gooches at their head, the locomotive superintendents are capable of doing signal service to the railway world, for there is much, very much, yet to be done with railway progress. But to trifle over a few broken axles, while the best method of raising, storing, preserving, and employing steam—the grand motive power of the whole system,—is as yet far from being established: this is merely to study the fracture of a harness-buckle, while the horse languishes for want of care and protection.

We must, therefore, hail with due thankfulness and indulgence, the efforts of the more inquiring and labour-loving individuals who devote themselves, as duty permits, to the study of railway-mechanism; and if report speaks correctly, we may be favoured ere long with the results of some extended series of inquiries, scientific and practical, which have been for some time in progress both on English and Scottish lines. Should the event prove agreeable to our expectations, we shall feel only too happy to assist in promoting the diffusion of useful knowledge. Be that as it may, we are glad to observe the dawn of a more liberal spirit amongst engineers of every stamp, and if engineers would further engage themselves occasionally in putting on paper what they very well know how to put in practice, they would deserve the highest honours of the state. But government patronage is not much known with us; were we encouraged by a minister of public works, as they are in France, we should easily acquire, from our own resources, the first engineering literature in the world.

ON THE PROPULSION OF STEAMERS.*

II.

In continuation of the illustrations of the varied forms of natural propellers, we now present two additional groups, one of aquatic, and one of aerial propellers.

Fig. 1: from Cuvier. The centrolophus. Some mullets have their caudal fins formed after this pattern—the lower lobe slightly projecting past the upper one.

Fig. 2: The gibbous sucker—common on the Atlantic shores, in which the under lobe protrudes still further, but is exceeded by that of the carp, fig. 3.

Fig. 4: Silver salmon, or piabuco of Brazil; from Bloch. Fig. 5:

* See P. M. Journal, page 221, *ante*.

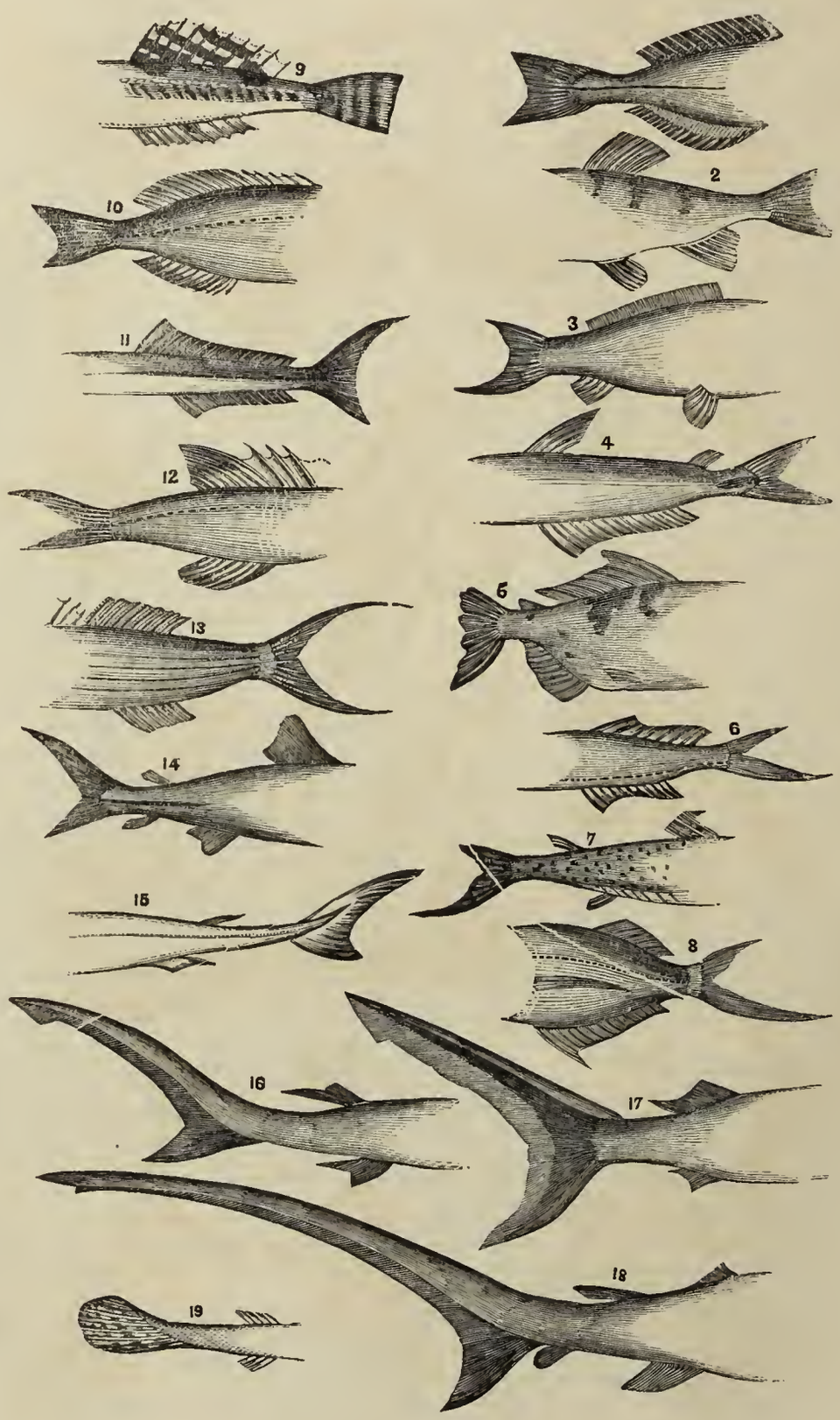
The pacu of Guiana, from Nat. Library. Fig. 6: Flying-fish, the extended lobe being the chief means of enabling it to spring out of its native element. Fig. 7: Shark-tailed hypostoma of Guiana, a fish little larger than a herring. The under lobe exceeds the upper in length by at least one-half, and is strongly spined at the extremity. In fig. 8 the disparity is still greater; it belongs to the genus Stromateus.

In the following specimens the order is reversed—the upper lobe, it will be seen, begins and continues to preponderate. Of fig. 9, the common hull-head of the Atlantic coast, the caudal fin is long, nearly even, and undivided. In fig. 10, the speckled redmouth, crescent shaped, has seventeen rays, and the upper lobe extended somewhat more beyond its fellow. In fig. 11, the northern crab-eater, the difference is more marked. This active fish, varying from 20 to 30 inches in length, ranges over a wide extent, being found equally on the coast of Africa and America. Fig. 12: A species of perch, from Bloch.

Fig. 13: Ruby-coloured etelis, from Cuvier. Fig. 14: Mackerel-shark, a terrible forager on the family whence its prenomen is derived. Fig. 15: The sleeper-shark; the figure represents, also, pretty accurately, the propelling organ of the sturgeon, one of the strongest of swimmers—a blow of its tail has broken a fisherman's leg. The same pattern of blade is seen in the sterlet. Fig. 16: the porbeagle-shark, from State Natural History, New York. The superior lobe of a specimen caught in New York waters, was two feet long, and furnished with a dilated fin near the tip—the inferior one ten inches. The stomach was filled with fishes. Like most of its relatives, it revels among shoals of shad, and pursues with equal success the fleeter mackerel. Fig. 17: The shovel-nosed, or hammer-headed shark, singular in its contour, and dreaded for its boldness, ferocity, and velocity. One caught on Long Island shore had its stomach dilated with detached parts of a man, together with his garments.

Fig. 18: the thresher, or long-tailed shark, known also as the fox-shark and swingle-tail, is the most remarkable of unequal lobates—the blade often exceeding the body in length. The upper lobe of one in the National Collection, is six feet seven inches long, eleven inches wide where it joins the body, and five inches at the middle of its length. The lower lobe only six inches long. In traversing the ocean diagonally—inclined to the horizon—this animal would undoubtedly beat the East India sword-fish; but in a race laterally, the later would leave the thresher behind.

GROUP III.—UNEQUAL LOBES.



Sharks exhibit a singularly apparent exception to the law which developes the superior lobe in excess in tribes that seize their food in the act of diving. From the recession of the lower jaw they are compelled to snatch their prey from below; but to do this they turn on their backs or sides, and hence the appropriate elongation of the upper propeller, both for overtaking and grasping their victims.

The saw-fish belongs to the shark family, and resembles the sword-fish in the position and length of its weapon. In full-grown individuals, the terrible instrument is over six feet in length, and the whole often plunged and buried in the body of the whale. Rushing from a distance, and accumulating momentum as its goes, the force acquired has driven the saw through the timbers of a ship.

To contrast the extremes of inequality in lobates still further, the blade of the garfish, fig. 19, is introduced, from a specimen recently caught in the Potomac, where they are common. It consists of one lobe only—not a nucleus of an under one is visible. The scales and vertebræ, or muscular part of the body, end by a sweep towards the upper margin, and there vanish. This feature prevailed extensively in remote epochs, and the present genus is remarkable as furnishing the only existing representatives of fossil families. Food was probably found chiefly at the bottom of ancient oceans.

Before taking leave of ichthyological propellers, specimens of other varieties, given in Group I., from figs. 11 to 20, inclusive, may now be glanced at. In them we see how nature cuts away material and alters

forms with the nicest discrimination, to meet infinitely diversified habits and movements. Where surface is useless, it disappears; where beneficial, it is made to shoot forth.

Fig. 11: Black bass, common on the coast from Florida to Cape Cod. It presents a remarkable conformation, of the outer boundary which, contributing little, if anything, to speed, is intended to influence movements, to meet requirements which naturalists may not yet have discovered. In the next figure —12: king-fish —the same feature is more strongly, but somewhat differently marked.

Fig. 13: the Brazilian bodian (from Bloch), size of the carp. Fig. 14: another variety of sea bass. The next is tridentated, a Chinese carp. Fig. 16: The orange file-fish, rarely found in New York waters. Fig. 17: the larimus, from Cuvier; and the nebris has the same form—both of the perch family. Fig. 18: Another lancet-shaped one, from the same. Fig. 19: The long-tailed unicorn of New York waters. Fig. 20: The horn-fish, or sea-bull (from Bloch), an inhabitant of East Indian seas, of curious structure, but one singularly ill adapted for speed.

The triangular form is found in amphibia. In seals (see the adjoining cut), the hind legs of quadrupeds are thrown back, and united at the heels; each foot retains its five toes, which, answering the purpose of radial ribs in tails of fishes, give strength and form to the connecting membrane, presenting a blade resembling those of the striped bass and salmon, figured on a previous page, while both produce a tridental posterior margin, and a general outline akin to that of the sea-bass, figured also on the page referred to, exhibiting, moreover, a striking likeness to the paddles of swimming and diving birds. In sea-leopards, sea-bears, lions, and kindred animals, each foot becomes lobed, furnishing analogues of ornythologic podiceps. From analogy, these creatures should be better divers than seals, but whether they have been sufficiently observed to determine this point, I know not.

GROUP IV.—SURFACE PADDLES.

As the movements of seals consist more in diving than in long lateral journies, the blade is transverse. So it is with whales, which have it lobated. Breathing air, they cannot remain long under the surface without suffocation, hence it is essential that they should have the power of rapid ascent and descent. The tail, as well as the body, of the porpoise, is adapted to great speed, and with what ease a shoal approaches a ship from a distance, plays round her, and disappears in the horizon, navigators are familiar.

Toads and frogs are other illustrations. The propelling blades of the latter are more pointed than those of the former, and they are known to be by far the best swimmers.

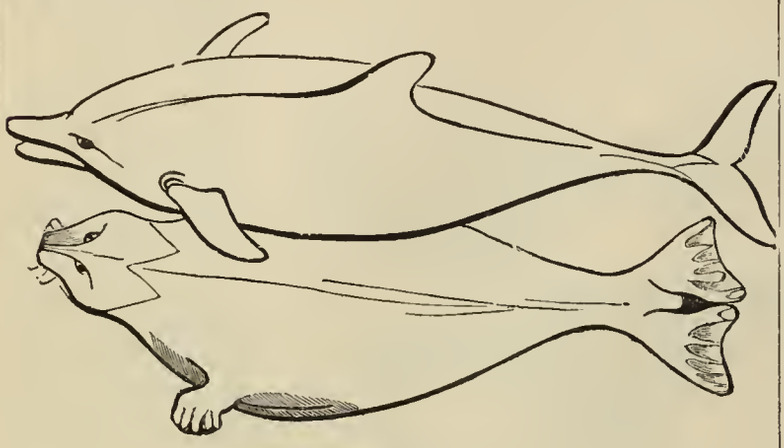
Had we been acquainted with frogs only from geological casts, we should have inferred their agility in water from the configuration of the hind feet, and the long jointed rods that wield them. This tribe of batrachians has the reputation of surpassing all four-footed creatures in swimming.

GROUP IV.

The superiority of pointed paddles is interestingly manifested in the musk-rat, figs. 1 and 2. This animal, in its habits and dimensions, is akin to the ornithorrhynchus, or water-mole of New Holland, fig. 3, and although with little or no membrane between its toes, is said, by those conversant with the habits of both, to be much the best swimmer. True, its superiority may be, in some slight degree, attributable to the use of its tail as a propeller; yet, notwithstanding this, the large undivided membranes of the foreign animal might have been thought sufficient to secure the advantage. Beavers and otters present other mammalian examples.

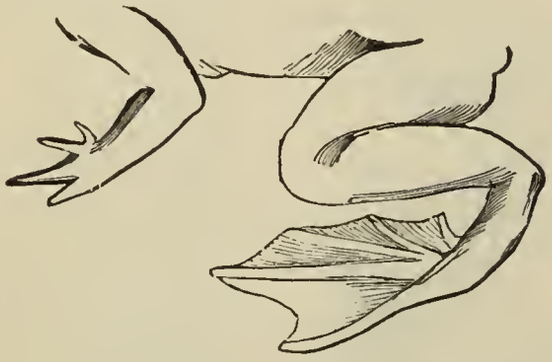
Of swimming birds' paddles, fig. 4 is that of the trumpeter swan, which, like most of its kindred varieties, is a powerful swimmer. Even when wing-broken, it passes through the water with great rapidity, and, if not otherwise hurt, an oarsman in the best constructed boat can rarely overtake it. Fig. 5 represents those of the gull family—all poor swimmers and worse divers, notwithstanding the expanse of propelling surface.

The penguin, fig. 6, leaves them immeasurably behind, with less face of blade. Quick on the water, and quick or under, penguins are thought by some the swiftest of swimming birds. They capture their prey by chasing—not by artifice.



Porpoise and seal.

Fig. 7: the Canada goose, and fig. 8, the left foot of the fishing-gannet, which bird, while surpassing the gull, does not equal the cormorant in gliding through the liquid element. A cormorant's right and left foot are figured at 10 and 11, the outer toes of the latter being the longest, and thus making the blade more acutely triangular. The gannet, cormorant, and pelican, have an additional membranous section, the hind toes in them being fully developed, while a nucleus only is seen in the gull, penguin, and nearly all feathery natants. In the cormorant, the area of the inner membrane is slightly larger than the middle, as it also rather exceeds the outer one. In the gannet, this order is reversed.



Fore and hind leg of a frog, half the natural size.

Fig. 9: a portrait of a cormorant. Of these birds it is remarked, they swim deep and dive with great expertness, so that it is all but useless to follow one when only slightly wounded. At times they swim under water with astonishing speed, pursuing and securing their prey, using their wings as paddles, and their tails as rudders.

Figs. 12 and 13: The grebe, among birds, furnishes an example of lobated paddles. The figures are specimens taken on the Potomac, where they are proverbial for agility and speed, disappearing at the flash of the sportsman's gun, so that ere the shot reach their position they are yards beneath and away from it. With flint locks they are hardly ever hit, and even dodge the best percussion caps. Indentation is here carried so far as to change a propelling blade into three distinct divisions, one governed by each toe. They rarely fly; their wings are imperfectly developed, and they have scarcely the rudiments of a tail. Water is their proper element, and, in the levers by which they work their paddles, a remarkable display of design is manifested, in so shaping the bones of the legs as to impart the greatest strength with the least material, and of such a form as to encounter the least resistance in the direction in which they act. In the figures exhibiting this feature, 13 is a side view, and 12 a front one; hence the section, instead of a circle, as in other birds, is rather like that of a knife blade. In grebes, penguins, and cormorants, the legs are placed far behind, so much so, that, to preserve the centre of gravity when standing on shore, they have to throw their bodies in a perpendicular position.

The fact is as full of significance as any fact connected with the subject can be, that, of all known varieties of soaring and natant propellers, existing or extinct, none can be quoted to conflict with the views urged in this essay. On the contrary, the closer they are examined the clearer becomes their testimony, and the more conclusive. Were they applicable to organs moving in one medium only, they might be questioned; but we find nature sanctioning them in aerial as in aqueous motive implements. She adheres to them everywhere.

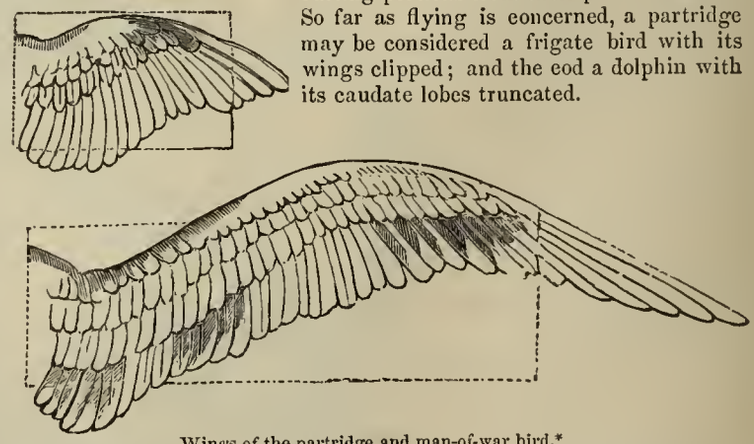
Bats, connecting quadrupeds with birds, have a large sheet of wing, composed of angular and pointed divisions. Their movements in the air resemble those of butterflies, and, although quick in changing their direction of flight, they cannot be classed among swift soarers. Both they and lepidopters illustrate the fact, that speed does not depend upon a large expanse of wing, so much as upon *form*. It is this that exercises a controlling influence. From examples given in Plate VI. it will be found that the fleetest of birds, as well as of fish, are indebted more to contour and length of blade than to surface.

Frugality in outlay of material, and consequently of power, is seen in every piece of mechanism turned out of Nature's workshop. Sufficiency without surplus—enough and not an atom over—are proverbs with her. An example worth mentioning occurs in bats. In flying organisms the tail is a rudder by which changes in the direction of flight are more or less promptly attained. It is so with bats, most of which prey on flies, which they hunt and swallow on the wing; but some feed on fruits, and these, requiring no such steering apparatus, have none.

Carolina bat's wing, half the natural size.

Among entomological illustrations are the sharp angled wings of butterflies, as the Jasius genus, known to surpass cognate tribes in flight. Of insects whose organs may be classed among lobates, is the sphinx, or hawk-moth family, remarkable for narrow and elongated wings. Then there is the boldest, fleetest, and most voracious of insectivora, the dragon-fly, preying on bees, wasps, and hornets, and far more readily overtaking butterflies, notwithstanding their broad expanse of wing. This fiercest of hunters has been described as darting from angle to angle with the velocity of thought, and as rapidly darting back—not turning in the air, but with a flash reversing the motion of its propellers.

In the next cut, a wing of the partridge and one of the frigate bird, *both of a width*, are placed together, illustrating the difference of form and proportions in the wings of slow and quick flyers: the latter extending further into the resisting medium than the former, agreeably to the universal rule in air as in water propellers, *increased speed* invariably accompanying *increased dip*, and *vice versa*—a rule we have not attempted to follow in our steamers, and hence the comparative failure of our laboured efforts. We cripple the flight of domestic and other birds by cutting portions from their pinion feathers. So far as flying is concerned, a partridge may be considered a frigate bird with its wings clipped; and the cod a dolphin with its caudate lobes truncated.



Wings of the partridge and man-of-war bird.*

For vigour and activity of wing the *tern* families are celebrated, and there is a strong resemblance in the conformation of their wings and tails to those of the tropic bird; the arctic jager, a most active plunderer, no sooner perceives a gull to have made a successful plunge, than he pounces on and makes it yield its prize. His wings are long, narrow, and very acute: so are those of the shearwaters, a class of oceanic plunderers whose flights are extremely rapid and protracted.

* The proper proportions have not been preserved in the above cuts. The former is too long, and the other too short. To Titian R. Peale, Esq., one of the naturalists of the Exploring Expedition, the author is indebted for some of the preceding illustrations.

AN EPITOME OF AMERICAN INVENTION IN 1849.

In our Review of the American Government Report upon Patents issued in 1849, we have elsewhere shown the extraordinary aggregation of inventions which pours in one continuous stream through the United States' Office. Such a collection must needs contain many startling novelties, which, if they do not always meet with due acceptation here, are yet valuable as the seed of future inventions, and as an extension of our stock of ideas. We may, therefore, not inaptly, place before our readers, a few of the more prominent features of the year's produce, an examination of which has already confirmed us in the opinion, that many of the inventions need only be explained to secure adoption.

Electro-Magnetic Ore Separator.—It is an old practice to separate iron filings from dust and particles of other metals, and also iron from its ore, by means of powerful magnets, the magnets in some cases being drawn through the mixed mass by hand, and then shaken or brushed, and in others the magnets have been attached to the periphery of a wheel or a drum, and either the mass has been dropped upon the revolving wheel upon one side, and the adhering iron removed by stationary brushes on the opposite side, or the magnets have been carried through the mass below, and the iron brushed off as before into a trough. By a process similar to this, the finest black sand has been prepared for many years. Much of the black sand now in use is coloured, and is common siliceous sand, but the best article is a ferruginous sand, separated by magnets from the white, red, and other coloured siliceous particles. The ore separator, which has been patented, uses electro instead of permanent magnets, rows of them being attached to a drum, the coils of wire surrounding the magnets being connected with a galvanic battery in the usual way, by one extremity, while the other is connected with a break-piece or cut-off, in such a way as to charge the magnets while passing through the ore, and discharge them at the proper time for dropping the adherent mass of iron, and depositing it in a trough which is inclined, to convey it to its proper destination. The mixed mass of ore and earth is conveyed from under a hopper upon an endless belt, to the electro magnets.

Telegraphs.—A variety of inventions under this head have been presented to the office, most of them based upon the electro-magnetic telegraph, or nearly related thereto. Prominent among these is the electro-chemical telegraph. Two patents have been granted for inventions of this kind, one of which has already gone into practical operation to a considerable extent. These inventions were adjudged by the office to interfere with each other, and upon a hearing, priority of invention decided in favour of one of the parties. Upon appeal, however, to the usual tribunal, it was decided that the alleged interference did not exist, and patents were ordered to issue to both parties. The whole case was one of unusual interest, involving many intricate and important questions, and although the whole proceeding was prior to your accession to the office, yet the leading features are doubtless by this time familiar to you. The parties, Samuel F. B. Morse and Alexander Bain, came into the contest for priority of invention upon unequal grounds, the former being a citizen of the United States, and the latter a foreigner. It was held by your predecessor in office, that under the law a foreigner could not go behind his foreign patent or printed publication for evidence of his invention, and upon reference of this subject to the Attorney-General, the opinion of the commissioner was confirmed. It was also held that, in a contest for priority of invention, the sealing of a foreign patent was not to be taken as proof of invention, and that proof of enrolment was alone adequate. On the appeal to Chief Justice Cranch, the parties appeared by counsel, who occupied some days in elaborate and lengthy arguments. It was, I believe, the first trial of appeal from the office, had in open court, and the whole case has been faithfully reported and printed at the expense of one of the parties. The report will be read with much interest by inventors and professional men.

The operation of the electro-chemical telegraph depends upon the chemical re-agency of the galvanic current. Marks or stains are made upon paper through which the galvanic current is made to pass, the paper being first saturated with some neutral or other salt, and moistened at the time to give it sufficient conducting power. The advantage claimed for this over the electro-magnetic telegraph is, that it may be worked with much greater rapidity. In the electro-magnetic telegraph, a signal is made by the development of electro-magnetism, and the consequent movement of a small bar of iron, both of which operations require appreciable time. In the chemical telegraph, the production of the stains or marks is commensurate with the passage of any portion of the galvanic current; for according to the best authorities, the current could not pass through the salt without decomposition. The change of colours, as indicated to the eye, may not be so sudden as the transit of the current but if it should not be so in fact, it becomes so practically, as the marks are not required to be seen at the instant of decomposition. I am not informed upon this point, but it is immaterial; the practical distinction between the chemical and electro-magnetic telegraph being this, that as it requires time to change and discharge an electro-magnet, and also to overcome the inertia of moving parts, there must be a limit in practice to the rapidity of making signals, while, in the electro-chemical telegraph, the limitation would depend upon other causes, and the rapidity of action would probably far exceed the ordinary mechanical facilities for communicating signals. With a view to avail himself of this greater capability of this telegraph over the above, one inventor has patented a means of preparing and transmitting communications much more rapidly than the ordinary manipulations with the key. To accomplish this, strips of paper are perforated by machinery, in such a manner that the perforations may correspond to the signs representing the letters, figures, or words, and by means of these perforations and the intervening spaces, or whole portions of the paper, the circuit is broken and closed with as great rapidity, as a slight spring pressing upon the strip of paper can be made to act. It is only necessary that the motion of the paper at the other end of the line which is to receive the communication should move with a corresponding rapidity. In practice it has been found that the rapidity of execution is much less than it should be theoretically; but, nevertheless, it is far greater than with the electro-magnetic telegraph. With this, as with all the plans for telegraphs hitherto undertaken, a difficulty of some importance has been encountered, from the imperfect insulation of the wires, although great pains have been taken to render the insulation as complete as practicable, and several patents have already been taken out for telegraphic insulators. As the insulated supports for the wires have to sustain a considerable weight, they must be made of considerable strength; and, moreover, as they have been made the sportive targets of lawless boys, and objects of less wanton though more malicious mutilation by mischievous men, it has been found necessary to give a due share of attention to strength and safety in this respect, and in so doing some sacrifice of insulating properties have been thus far deemed necessary. A curious result follows from this want of insulation. If it be assumed that the air is impervious to galvanic electricity, all that can return to its source between two distant stations, without travelling the whole distance, must pass down each post on the line, and can only reach the post through the substance of the insulating material employed, or along its surface in case it should be moist. A greater amount of electricity will pass down those posts nearest the station where the battery is in operation, and at the extreme end of the line only a feeble portion will pass through the instruments. The consequence of this has been, that upon the conductors being moistened upon their surfaces, the instruments at the distant stations would work with unequal power, and occasion much embarrassment. This difficulty is in some measure remedied, by having batteries at each end of the line, or at every station, although the defective insulation still exists for each. I am inclined to think, however, that the air, when loaded with moisture, is a conductor of galvanic as well as of mechanical electricity, as indicated by my experiments, several years since, with the immense copper roof of the Patent Office, forming a great galvanic plate of upwards of 20,000 square feet of surface. If it is sufficiently so to be of practical value, it is obvious that entire insulation of telegraphic wires will be difficult to accomplish.

The crossing of rivers and large bodies of water, by means of submerged wires, does not seem yet to have been attained, and the chief obstacle thus far is imperfection in the methods of insulation. The plan which I proposed several years since appears to be worthy of trial. It consists in using a local circuit and battery of quantity at each river or body of water. The galvanic currents employed on the main routes are of small quantity and high intensity, hence a slight defect of insulation in a submerged wire would be productive of a great loss. But by using a current of quantity and the lowest possible intensity, to be set off by a local magnet, I am inclined to think that a single wire laid in the river with the most ordinary preparations for insulation, would be effectual in establishing connection between the terminations of the great line on opposite sides of the river or other body of water. It has long since been proposed to connect the eastern and western continents by means of telegraphic wires laid down in the depths of the ocean, and lately the proposition has been revived with a venturesome and true American spirit. It does not appear in any way impracticable to stretch a wire from the American continent to England; and in the waveless depths of the interminable waters, the wire would be more secure from depredation than upon *terra firma*. From its weight it would sink beneath the realms of the living monsters, and lie far out of reach from the ruthless hand of mischief or speculating avarice. But the insulation of such a wire is a thing not easily conceived of, in the present state of our knowledge. Besides the mechanical niceties required to obtain a complete insulating covering for the wire, we should have to contend against the

corrosive action of the sea water, and this too at a point where its greater density would exalt its chemical agency. Much has been expected and promised from gutta percha as an insulator, but we have not been long enough acquainted with this curious substance to test its value for this purpose. It is indeed a most excellent electric and insulator, but I have seen several instances of its decomposition when exposed to air and moisture, and some cases of its entire destruction when in thin sheets. I have been recently informed that the decay of thin sheets of gutta percha is attributed to caustic materials used in preparing it; however this may be, I have seen supports for telegraphic wires made from the pure gum, undergo in one season decomposition to such a depth as to form a bibulous mass upon its surface, and materially impair its non-conducting property. It resists, however, to a remarkable degree, the action of strong acids, and may be used with great convenience for funnels, syphons, &c., for transferring and holding even strong nitric acid. It may not be out of place here to mention its unfitness, when in very thin sheets, for models of patented inventions. During the past year a patent was granted for a surgical instrument, an essential part of which was a sac of gutta percha. In the course of a few months the entire sac had disappeared, having crumbled into powder.

American Indicating Disc Telegraph.—An instrument under this name has been patented, which presented some ingenuity and novelty in the mechanical arrangements, and also in the selection and use of signals. It is an optical or indicating telegraph, as its name purports, and in this particular must yield to the recording telegraphs. The signs are indicated by the figures 0, 1, 2, 3, 4, these being the only symbols used. These stand for the vowels, and the remaining letters are represented by combinations of these figures. The figures are arranged in four sets, upon the face and near the circumference of a disc, which revolves by means of a novel internal escapement, which is moved by a lever attached to the armature of an electro-magnet. Its language is less complex than that of other indicating telegraphs.

Pen Telegraph.—When Professor Morse's telegraph was first essayed in this city, it recorded the signs upon a moving fillet of paper by means of a pen charged with ink, the pen being supplied from a reservoir or fountain. It was found difficult to regulate the flow of the ink, more especially as the motion of the pen was apt to *throw* the ink, as it was termed, and the pen was accordingly dispensed with, and a contrivance substituted, by which marks corresponding with those made by the pen were indented upon the fillet of paper. This required some mechanical force, and it became necessary to have a local registering magnet, as it is called, of some power to supply this force. In the new pen telegraph, the inventor has ingeniously reversed the order of Morse's telegraph, and moves the paper to the pen, which is kept stationary, thus obviating the difficulty of throwing the ink, and requiring a slighter force to move the paper than is now required to indent the paper. The pen is also fed by an ingenious contrivance. A lever or arm, carrying a feeder which dips into a fountain of ink, is operated at the requisite intervals so as to move up to the pen and deposit upon a proper amount of ink, and then retire again to the fountain to recharge. This arm carrying the feeder is actuated by the clockwork which is used to move the fillet of paper. It was thought that this invention would save the necessity of using a receiving magnet, and that the telegraphing might be performed directly by the use of one magnet merely to move the paper to the pen. If, however, it fails to supersede the receiving magnet, it can have no advantage to recommend its use.

Painting Telegraph Wires.—A patent has been granted for a machine for painting telegraph wires, to preserve them from rust. The invention is notable, not so much for intrinsic merit or novelty, but as marking the progress and rapid extension of the telegraph, by the introduction of labour-saving machinery in the manufacturing departments of the art. Attempts have also been made to patent modes of insulating the wires, and of forming them into ropes of suitable size and strength; and although the telegraph might have, and in some cases has, been benefited by their use, yet they were not in the category of novel inventions, and could not be patented.

Mode of sustaining Telegraph Wires across Rivers.—Many attempts have been made to improve this part of the telegraph system, and generally but little difficulty has been experienced, except where the wires and piers might become an obstruction to navigation. If the piers are to be very far apart, there is danger of the wires breaking under their own weight, and more especially when loaded with ice. The plan in question proposes to suspend the wire to a cord of India-rubber, stretched to its greatest tension, or nearly so, or what is better, to enclose the wire in a tube, which is to be stretched over the wire; this would save much swagging of the wire, and as the India-rubber is a very strong material in proportion to its weight, the invention appears feasible, and is at least very ingenious.

Railway Annunciator.—Another kind of indicator, patented under the head of telegraphs, (although wanting the characteristic distinction of communicating at a distance,) is an instrument bearing the above name. In principle, it is similar to an odometer, but might be appropriately termed an odoscope. The odometer is an instrument attached to the wheels of carriages, which, by means of an index moved by a train of wheelwork, shows the distance passed over by the carriage; but this instrument is to show more than this, and informs the traveller where he is on the road, or the name of the place he is passing. For a taciturn people, as we are, the invention may be styled an ingenious hit, where the travelling stranger is reluctant to ask, and everybody appears too much absorbed to inform him of his whereabouts. The names of the various places on the route are marked upon a dial-plate, and the index or hand shows the cars to be at a certain place when it is over its name. The index revolves by a train of wheelwork connected with the car-wheel or axle, as in the ordinary odometer, the office of which it also performs. It has another convenience, of giving notice to way passengers of the approach to their destinations, and to hold themselves in readiness for leaving the train without delay.

Clocks.—There would seem to be but little space left for improvement in clocks at the present day, but, like every other invention of man, it must have a long interval between a high degree of improvement and absolute perfection. Not much has been done towards filling this interval, but a patent has been granted for one improvement which may be of practical interest. This invention consisted in the employment of two coiled springs, instead of one, to operate upon a pinion placed between them, for the purpose of equalizing the friction upon the bearings of the pinion. This device, or its equivalent, or certainly its analogue, is common in machinery, but it was deemed patentable in this instance, as, by its application to clocks, each spring could be made light, thin, and of better materials, in consequence of using two.

Spectacles.—Three patents have been granted for improvements in spectacles. The first to be mentioned is for a compound spectacle, or one in which several sets of glasses are used of different focal powers. There are several minor points claimed under this patent, but the principal feature is gearing the stems of the frames enclosing the glasses, in such a manner that two glasses of one set shall move together and in unison. One other feature also of this invention is the mode of affixing the sliding handles, in such a manner that they make a comparatively smooth joint, and avoid the annoyance so often experienced in common spectacles of catching in the hair.

The next patented improvement in spectacles to be mentioned is one in the slide merely, and accomplishes, in a more perfect manner, the object sought for in the last-named invention. One half of each bow is made tubular, and the other slides within it with a neat fit, and the bows are not so heavy as in the ordinary spectacles, and there is, of course, no risk of entanglement with the hair.

The third improvement in spectacles relates to the lenses. Spectacles are frequently made with the upper and lower halves of the glasses separate, and of different focal powers. The dividing line is unsightly, and unpleasant also to the wearer. The new method patented makes the glass for each eye entire, by grinding the upper and lower portions to different focal distances, and thus dispenses with the line which commonly gives to the glasses the appearance of being cracked. It will undoubtedly subserve the purposes for which it is intended, but it will at the same time be a difficult task to grind the lenses in this manner.

Transverse Callipers for Measuring the Interior of Casks.—A convenient instrument under this name has been patented, two modifications being presented under the application, one of them intended to measure the longer, and the other the shorter, diameter of the cask. The legs of a pair of common compasses, bent about their middle nearly at right angles, and crossing each other, will convey a good idea of the form used for measuring the longer diameter, or the distance between the heads. That for measuring the shorter diameter, or the swell, consists of two sliding arms attached to a rule or scale. These arms are inclined towards each other, making an angle of 45° with the rule, and, of course, a right angle between themselves; and from the relation of the right angle to the circumscribed half circle, it is obvious that the instrument is philosophically contrived, and well suited to its purpose.

Musical Notation.—Of the many new systems of musical notation which have been before the office, very few have ever been regarded as anything more than arbitrary selections of signs, innovations and not inventions. A patent has been granted during the year for a new system of musical notation, which is based upon important principles, and has been the source of much excitement in the musical world. This system does away with the signatures of flats and sharps, and accidentals, and greatly simplifies the reading of music. Should it answer all its pretensions, it will have much to contend against before its general

adoption. Scholars and masters will have to unlearn, and the vast quantity of printed music, now in use and on the hands of dealers, would be sacrificed. Thus far, I am informed, the most skilful musicians cannot bring any serious objection to the system.

New Flute.—A patent has been granted for an improvement in this instrument, of considerable interest to musicians. A and E natural are the poorest notes upon a flute, and cannot be sounded with as much volume as other notes, in consequence of the smaller size of the holes for the third fingers of the right and left hand. The inventor has found, that if these holes be carried lower down upon the flute, they can be made larger, and thus give full tones. But in carrying them farther down, the interval would be too great for the spread of the fingers; and, to accommodate the flute to this change, he has provided a key for these holes, which is touched by the fingers at the same point on the flute as the former small holes, and thus to the player there is no essential change in the mode of fingering.

Machine for Folding Paper.—This curious and quite novel instrument folds the paper by passing it between pressure rollers, and works with great rapidity. It is too complicated to receive more than this passing notice of its main principle of action.

Paper Filer.—A neat contrivance, consisting of a tin box, with a hinged cover folding over its end and part of one of the sides for securing the papers, and an open space on two sides of the cover, allowing an easy inspection, withdrawal, and insertion of the papers.

Daguerreotype Case.—This is the invention of a lady, consisting of a conical glass case, blackened on the upper half of its inner surface, and ground on its lower half to admit the light necessary for viewing the picture, which is secured in the larger end of the case, the smaller end being provided with a magnifying lens, through which the picture is to be examined. In the ordinary examination of these pictures, every one must have observed the difficulty of getting a proper light. The specular reflection of the plate interferes with the view, and it is necessary to admit the light to the plate laterally, and hold over it some dark or absorbing surfaces. Persons wearing dark dresses can generally obtain a good position without much trouble. This inconvenience is obviated by the invention, and as the picture will bear magnifying with advantage, the lens comes in opportuuely for this purpose, as well as that of closing entirely the glass case, and preserving the picture from dust and exposure to the air.

Holding Daguerreotype Plates.—Two patents have been granted for inventions for holding the plates while polishing. They are both clamps of novel construction, and intended to hold the plate upon a polishing wheel, and the other for holding it upon the table or bench while polishing with the buffstick; both of them apparently good inventions.

Lung Protector.—A simple and ingenious instrument, to be placed over the mouth and nostrils, having two valves—one for inspiration, and the other for expiration. The induction or inspiring valve may admit air through a sponge or heater, and the eduction valve opens to the air. One valve is operated by one nostril, and the other by the other, so that the air which has been breathed does not pass through the chamber which admits it, as it does in the common respirator.

Milk Exhauster, or Instrument for Milking Cows.—A curious device to save labour. Mechanical means have been before used to draw milk from cows in cases where there was an accidental or natural obstruction, but this invention is to milk cows by the wholesale. It will probably answer well in many cases where the cow will submit to its use. It consists merely of a probe and canula attached to a sac of India-rubber or gutta percha. The canula or tube of silver is inserted into the teat, being led by a probe which projects through it, and when the tube is far enough, the probe is withdrawn, and the milk flows in a continual stream. The sac is made like a glove finger, and is tied around the upper part of the teat, serving to hold the canula in place, and keep the teat warm, which is supposed to be au object.

Atmospheric Churns.—The subject of churns belongs to the class of agriculture, which class will be reported upon by the examiner having that branch in charge. In consequence of an unequal apportionment in the number of cases, I have had, during the year, 49 applications transferred to my desk, and among them 21 applications for churns. Most of these were styled atmospheric churns; and since I have been in the patent office, I have never witnessed such a *mania* upon any one invention. The first impulse seems to have been given by the grant of a patent for a churn, in which there were boxes upon opposite sides of a common revolving dasher, so situated that, as the dasher revolved, the box containing the cream, with its open mouth downwards, carried down a portion of air to the bottom of the churn, and as the mouth of the box inclined upwards, the air escaped from it through the mass of the cream, while the box itself filled with the cream, and as it came out and revolved in the upper part of the churn above the cream, that contained in the box was thrown out and scattered into spray. Both the descent and size of the box occasioned a commingling of the air and cream, and answered the purpose of agitation as well perhaps as any form of dasher. In the report of last year, the *rationale* of atmospheric churns was given. It may be well to repeat, that the introduction of air plays no chemical part in the production of butter, its separation from cream being merely a mechanical process. And although the atmospheric churns operate to a considerable advantage, yet it is by means of more thorough agitation, which is increased greatly by the diffusion of air throughout the cream. As each portion of air rises through the cream, it forms a bubble upon the surface before it escapes; and in some of the atmospheric churns where the dasher is constantly submerged, the whole mass of cream is converted into a complete mass of foam. From the success of such a churn as that above named in producing butter in a shorter time than other churns, a most enthusiastic speculation was at once commenced upon atmospheric churns, and inventive powers were racked to modify, mystify, and contort a simple principle, with a view of producing novelties rather than improvements. From the immense number of churns used throughout the country, great gains could not fail to follow the monopoly of a new and superior churn. The golden prospects have tempted many into the field, and it is quite curious to observe in this instance the natural drift of intellect, bringing the workings of independent minds into one common channel. A patent was granted for one species of atmospheric churn; but before this could have been known far beyond the walls of the patent office, two other inventors, each and all from different parts of the country, had laid claim to the identical improvement. One was from Ohio, the second from Illinois, and the third from Vermont. An interference was accordingly declared, and no sooner had the decision been made in favour of the patentee, than three other inventors were found pressing their claims to the same invention. It presents an unprecedented case in the history of the patent office, of seven persons, each a *bona-fide* inventor, all claiming the same thing, and about the same time, and all from distant portions of the country. This improvement consists simply in boring a hole through the entire length of a common upright churn dasher, and placing a valve either at the bottom or top of the dasher. This valve opens downwards, and when the dasher is raised with such rapidity that the cream cannot follow up, the air rushes down through the valve under the dasher, and upon the downward stroke the air is pressed out laterally, and escapes by the side of the dasher, and up through the mass of cream. It requires not a very quick motion and but little force to effect this, and the agitation is most complete. A full-sized model was exhibited in the office, showing the operation with clear water only. Upon agitating the dasher, the water appeared as if in intense ebullition. Another peculiarity belongs to this churn worthy of note. In the common churn, the dasher has to be raised out of the cream at each stroke, and plunged down with some force, and as this scatters the cream, it is necessary to cover the churn tightly, and allow the dasher to play through a small hole in the centre of the cover; but in this atmospheric churn the dasher is kept always under the surface of the liquid, and consequently there is no splashing of the cream, and the cover may be left off with safety, and enable you to watch the operation. A strong recommendation is its simplicity; and as one of the inventors stated, he could alter any common churn dasher to this principle for twenty-five cents.

Prior to this simple device for introducing air, several complicated inventions had been patented, and many more made and presented to the office to effect the same purpose. In truth, this invention at first was not considered patentable; but after the exhibition of its actual operation by one of the inventors, a different view was adopted, and a patent ordered to issue. As atmospheric churns were not new, the ground was taken that the use of any known means of introducing air was not patentable. The ground of action is correct in itself, but did not appear applicable in the case after a personal explanation from the inventor, and an exhibition of the operation and result of his invention. The patentability of an invention frequently turns upon a nice point, and inventions the most novel are sometimes the most worthless; while again others least novel in appearance, bearing the similitude of common and unpatentable devices, are most valuable and important in practice. Simplicity is the essence of true invention, and it is often interesting to see, after a multitude of complicated inventions to attain a certain end, some discerning or perhaps fortunate inventor demolish a whole labyrinth of combinations, and arrive at the result by means so simple as almost to rob invention of its charms.

> "The Invention all admired, and each how he
> To be the inventor missed; so easy it seemed,
> Once found, which, yet unfound, most would have deemed
> Impossible!"

SCHIELE'S GRINDING-MILL WITH ANTI-FRICTION CURVE-FACED STONES.

(Illustrated by Plate 66.)

Mr. Schiele's beautiful invention of what we have termed the "Anti-friction Curve" for rotatory rubbing surfaces, has already been laid before the readers of the *Practical Mechanic's Journal*,* with a promise, on our part, to give some examples of the adaptation of the principle to practical ends. We now redeem this promise by an illustration of the actual application of the curve to the grinding surfaces of millstones, and to the bearings of vertical shafts.

The flour-mill which we have chosen as the subject of our illustration is self-contained, that is, it is an independent machine, and is ready for use the moment it leaves the maker's hands, or is set down on the spot it is intended to occupy. Four such mills, placed together, may be conveniently worked in a room of 10 feet cube, a single shaft driving them from the centre. Fig. 1, on plate 66, represents a vertical sectional elevation of the mill complete; and fig. 2, is a plan corresponding.

The grinding surface of the upper stone or runner, A, and the corresponding surface of the lower, fixed, or bed-stone, B, are accurately formed to the contour of the "anti-friction curve," so as to insure a perfectly uniform wear, and dispense with the existing necessity of renovating the surfaces of the common flat stones. The mill is driven by two carriers, C C, bolted to the runner, the arms of a pulley, D, being set to bear against them, to work the mill by a strap. In each of the carriers is an eye, to receive the hook for the chain employed in lifting the runner out of its place when necessary. The pivots, E E, of the shaft, or mill-spindle, are likewise formed to Mr. Schiele's peculiar curve. They run in brass steps, resting in sockets, F F, which slide in the bosses of the top and bottom frames, bolted to the bed-stone. The adjustment of the grinding surfaces, is effected by turning the adjusting screws by a key, G, so as to raise or lower the runner, as required; and to prevent the flying off of the grain, the runner is encased with a cast-iron barrel, H. The feeding apparatus for the supply of the grain, or material to be ground, consists of a hopper, fastened to a pipe screwed on to the barrel, H. A taper plug, I, is adjusted by the screw, K, and shaken by a spring, L, acted upon by the irregularities of the strap against which it is pressed.

The entire machinery is carried on a strong timber frame, M, closed up all round to keep in the flour or dust. This is partly effected on one side by a cloth, or other flexible cover, N, tied round the key, to allow the latter to turn. The front partition is loose, and removeable by a handle, O. In this enclosed space, a partial vacuum, and, therefore, a current of air down the grinding faces, may be produced by a ventilator, or by a species of chimney draught. This arrangement produces the same effect on fine flour as the ventilating high speed of common millstones.

Fig. 3 represents a vertical section of one kind of ventilator, which Mr. Schiele has adopted for exhaustion in some of his mills. It is driven by the mill-strap. The wings are six in number, three of which are only half the size of the others, for the purpose of compensating for the increasing space between the wings nearer the periphery. The wings are fastened to a circular top plate, having a cylindrical portion to act as a pulley, which plate is again secured on the spindle working on two of the anti-friction curved pivots. The curved shape of the wings, and of the outlet of the pipe, possesses the qualifications of guiding the air easily in its escape, compensating for quicker speed and enlarged space near the periphery, and throwing the air, escaping on the side of the wings, towards a curved surface, which prevents its return. The contour of the wings towards the inside serves to get the air gradually into rotation.

In mills of this kind, when, by wear, the runner has sunk three inches, the adjusting screws of the steps arrive at the end of the three inch traverse allotted to them. The runner is then lifted from its seat by the carriers, the shaft is taken out, and the thin end of the runner is shortened to the extent of three inches. The cast-iron bush, P, thus set free, is placed on the shaft under the boss of the pulley, to keep it at its former height. The wooden packings of the carriers, C, are lengthened, the runner is again brought to bear against the shoulders of the shaft, and the steps or bearings are screwed up to their original height. This plan of renovation may be repeated twice, thus allowing for wear to the extent of twelve inches in a mill with a 26-inch runner; after which, the fittings are fastened to a new pair of stones, the old ones being still valuable for the manufacture of smaller mills of different sizes.

The peculiar portability of these mills is a valuable feature of improvement. No fixtures are required, as the weight of the parts insures steadiness in working. Perfect uniformity of wear in the grinding surfaces is attained by the use of the curved face, and the expensive dressing necessary in flat stones is here entirely obviated, as the occasional grinding of hard substances roughens the faces to an extent sufficient for grinding all the softer materials, which gradually smooth down the faces.

Any of the materials ground in common mills, and many which the latter cannot properly act upon, are capable of reduction in these mills. For flour and other finely ground substances, a few air-channels are formed down the face of the runner. Their best speed is only half that of common stones, and the inventor states that his experimental results go to show that a two feet runner produces as much flour as a four feet flat millstone, the power required being a minimum. If the stones run empty, no contact can take place, therefore there is no firing, nor does a variation in the feed or speed cause any difference in the relative position of the stones, on account of the firm and steady revolution on the curved pivots. The anti-frictional qualities of these pivots are pretty well elucidated by the fact of the very minute consumption of oil upon them.

Of course, the old plans of mill gearing and shafting answers for driving the mills, and even the varying movement of wind-mills and tide-mills may be made use of for working them. There is at present one in course of manufacture, where a small steam-engine is fixed against the bed-stone for driving the mill.

The results obtained from the use of the ventilator are sufficiently satisfactory to recommend it for the ventilation of mines and manufactories. It may also be judiciously applied as a blowing fan, being then encased in a vertical position, keeping about six inches clearance all round the periphery, and leading off the exit pipe from any convenient point.

The inventor states that half a gill of oil will lubricate the pivots of a mill and ventilator for an entire year. We may here remind our readers that Mr. Schiele is the patentee of the application of the anti-friction curve, in the manufacture of cocks, valves, lathes, screws, bearings, and similar rotatory movements. At the inventor's workshop, in Granby Row, Manchester, may be seen a great number of examples of the application.

* Pages 50 and 82, Vol. II.

COPROLITES.

The beneficial results of the application of scientific knowledge and principles to the commonest operations of life, are daily manifesting themselves in our manufactures, in our commerce, and even in our agriculture. Few minds possessed of great scientific acquirements appear to have applied themselves to the consideration of the mode by which the productive powers of the soil might be artificially increased, until the discoveries and theories of Dr. Liebig were made public in the year 1840. Till that time it had been the custom to look upon the raising of crops and other farm produce, as a matter of so simple a nature, that it did not require the aid of science, and was best performed according to the simple modes suggested by the experience of bygone times.

Signs of altered times are now visible, and our farmers and landed proprietors are alike beginning to find that the knowledge of the chemist may not only assist him, by teaching them the constituents of the soil, and the requisite ingredients necessary to increase its fertility, but by pointing out new sources whence the requisite manures may be cheaply and easily obtained. A curious and important case, which illustrates the practical value of scientific knowledge upon such subjects, was tried before the Lord Chief Baron, at Guildhall, London, on the 23d December last. It was an action brought for the alleged infringement of two patents—one obtained by a Mr. John Bennet Lawes, and the other by Sir James Murray, the well-known inventor of the "Fluid magnesia." It seems that Mr. Lawes, who is a gentleman of fortune, and an amateur chemist, having made some experiments in the manufacture of manures, took out his patent for what he termed "certain improvements in manures," which bore date the 23d May, 1842. Sir James Murray's bore date the same day, and was entitled for "an improved method of combining various materials, not hitherto in use, for the purpose of manure." The identity of date gave rise to a curious question not hitherto decided, namely, what would be the effect of two patents for the same invention, bearing the same date? The learned judge, however, who tried the cause, considered, in the present case, that there was sufficient distinction between the two inventions to render it unnecessary to decide it.

Mr. Lawes became entitled to the benefit of Sir James Murray's patent by purchase. The claim put forward by Mr. Lawes' patent, as varied by a subsequent disclaimer, was threefold:—1st. The manufacture, for the purpose of manure, of superphosphate of lime from "calcined bones, apatite, phosphorite, or any other substance containing phos-

GRINDING MILL.

C. Schiele, Engineer
Manchester.

Fig. 1.

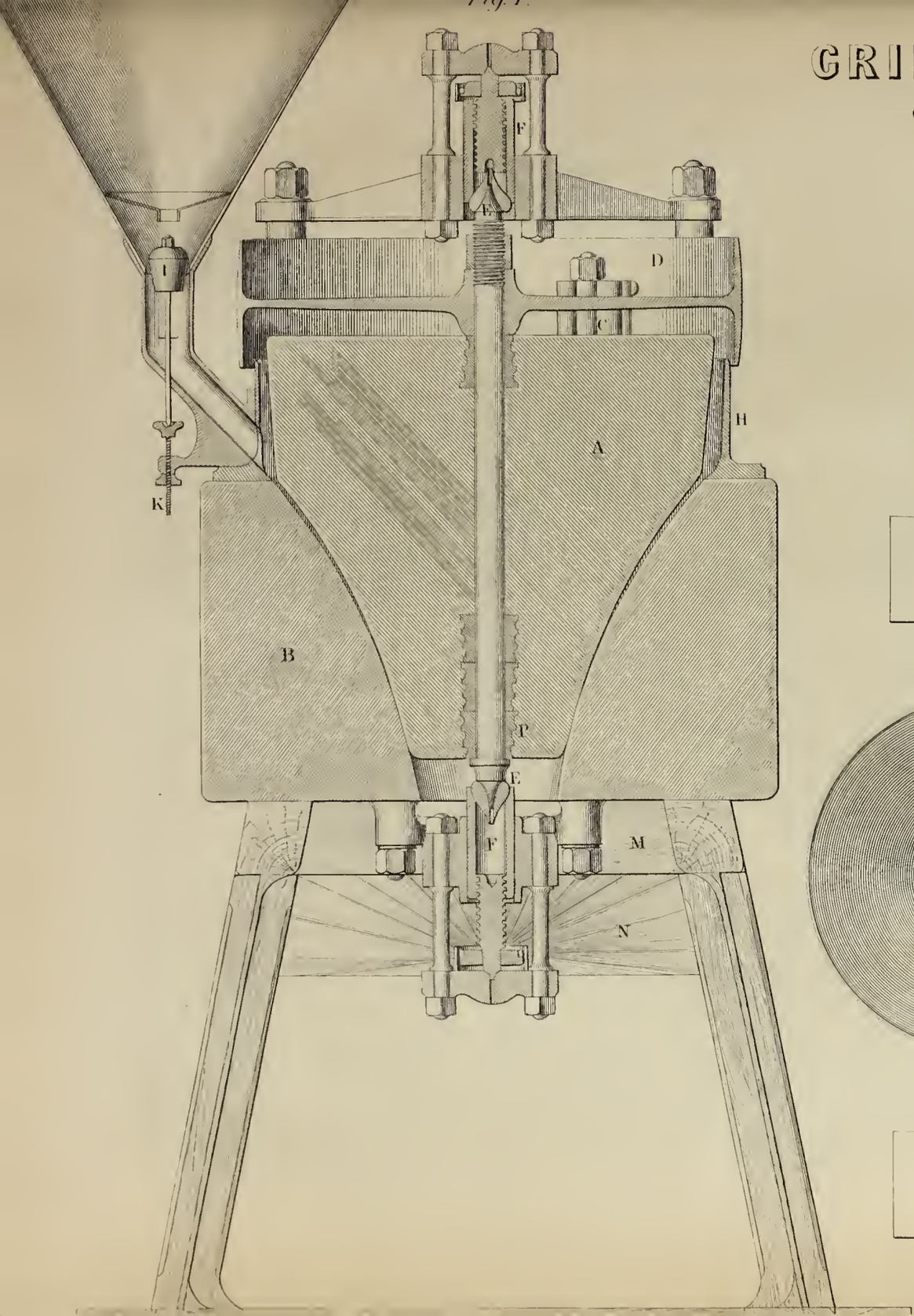


Fig. 3.

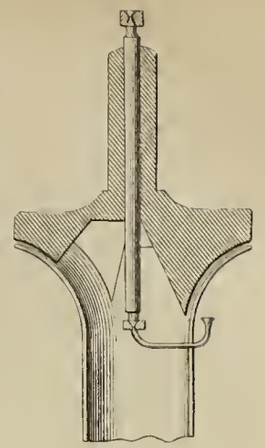
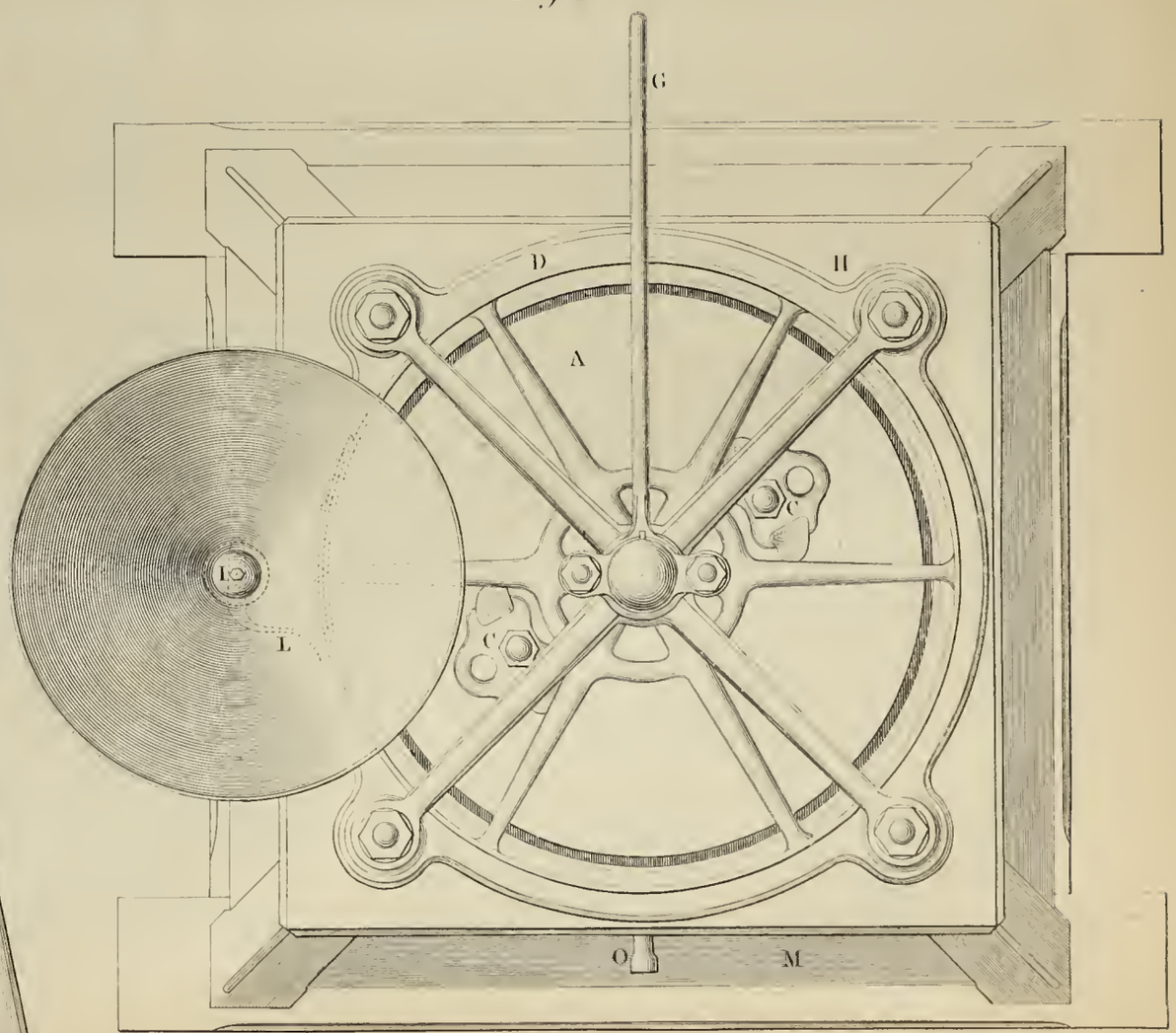


Fig. 2.



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phoric acid," excepting bones and bone dust, by the application of sulphuric acid. 2d. The use for manure of the combinations of phosphoric acid with soda, or potash, or magnesia. 3d. The use for manure of a combination of silica with soda or potash, or the casting on the soil of ground glass or crystal.—It is not quite so easy to state shortly the effect of Sir James Murray's patent, but the main object of it appeared to be the "absorption into porous or powdery substances," such as sawdust, ashes, or other dry rubbish, of the mineral acids, with a view to make them more easily applicable to the soil as manure.

The London Manure Company had for some years carried on a very extensive business in making a variety of manures, in Bridge Street, Blackfriars, and among other manures sold by them was superphosphate of lime, which is now recognised by farmers as a most valuable manure for turnips, wheat, and other crops. In the manufacture of this superphosphate, they had been in the habit of using considerable quantities of certain fossils which are found in extensive beds in the red crag of the Suffolk coast, whence some hundreds of tons have been brought to the London market under the name of "coprolites." Mr. Lawes claimed the exclusive use of these "coprolites," under the words in his specification, "other substances containing phosphoric acid," and commenced his action against the Company in July, 1848. He, moreover, asserted that there had been a violation of Sir James Murray's patent, in selling the superphosphate in a dry powdery state. To the eye of a careless observer, the bulk of these coprolites present the simple idea of ordinary pebbles or stones; but in that of science they have a profounder meaning—they are the wreck of a world which teemed with animal life in its hugest forms, unnumbered ages since. They form layers or beds in the red crag, varying in thickness from a few inches to several feet, similar to the bands of flints, which no doubt many of our readers have seen in chalk-pits. As the cliffs of the Suffolk coast, in the neighbourhood of Felixstowe, become undermined by the action of the waves, and fall in masses upon the margin of the sea, these coprolites are easily collected in large numbers by boys and others, who thus obtain a livelihood. Many, less worn than others, have a cylindrical shape with spiral convolutions, while others betray their origin, and present the appearance of fragments of bones and teeth.

The merit of having pointed out and suggested the practical use of these particular substances belongs to the Rev. Professor Henslow of Cambridge, who read a paper on the subject before the Geological Society, in October, 1843. His then opinion, and that of Dr. Buckland, who was the discoverer of the Lias coprolites, was, that they were the fossilized dung of extinct carnivorous animals or fishes, the "album Græcum" of the antediluvian world; hence they were originally named from the Greek, coprolites, or *dung-stones*. This opinion was founded upon the general shape of those which exhibited, as before mentioned, spiral convolutions, which they might have obtained by passing through the intestinal canal of the animals which voided them; and also upon the fact, that analysis proved them to contain from 53 to 61 per cent. of phosphate of lime, a quantity about that usually found in the bones or the excrement of dogs and other carnivorous creatures. The researches of Professor Owen have, however, determined that they are mostly the waterworn fragments of the bones of whales and cachalots of extinct species. In his work on the British Fossil Mammalia, he has figured some of the more remarkable, as the earbones of different species of Balænæ, and calls them Cetotolites, or whales' earbones. He regards the term coprolites, as applied to all the specimens which have come under his notice, as a misnomer. He observes, that "four species of Cetacea referrable, by the form of the tympanic bones, to the whale family, but distinct from all known existing species of that family, are more definitely indicated by the remarkable fossils termed Cetotolites; and it is not improbable that these and the teeth may have been parts of the same cetaceous animals. We know that the great whalebone whales of the present day, before their jaws acquire the peculiar array of baleen plates, manifest a true dental system, although the fœtal teeth are transitory, and never destined to cut the gum. And as the embryos of existing Ruminants feebly and evanescently manifest in the dark womb, by their upper incisors, their divided cannon bones and hornless foreheads, the mature and persistent characters of their ancient predecessors the Anoplotheria, so may the equally ancient whales of the Eocene seas have retained and developed those maxillary teeth which are transitory and functionless in the existing species. But the light of these analogies can give but a dim and distant view of the actual generic characters of creatures whose former existence is revealed to us by a few fragments of their fossilized skeletons, which have been bruised and worn by ages of elemental turmoil. It may be surprising to many, but not more surprising than gratifying, that the means of investigation at present at our command enable us satisfactorily to determine from such fragments, not only the kingdom of nature, but the class and the order to which they belonged. They further prove that those ancient mammals of the deep appertained to the carnivorous section of Cetacea in the Cuvierian system."

It is the opinion of geologists, that these fossils have been washed out of the subjacent Eocene beds of London clay, which refers them back to almost the earliest geological epoch at which the remains of any species of mammalia have been found. Thus has scientific genius, combined with modern improvements in our means of investigation, discovered the astonishing fact, not only that we are daily burning on our hearths the wood of forests which waved over the morasses of antediluvial continents, but are actually spreading as manure over our fields the bones of those great monsters that animated the depths of oceans which once covered the now habitations of men.

It is not our purpose here to give a report of the trial, as although a number of the most eminent scientific men of the day appeared as witnesses, yet their evidence was necessarily confined principally to details of practical chemistry; and we shall therefore content ourselves with quoting the remarks of the Lord Chief Baron, whose scientific acquirements conspicuously fitted him to preside on such an occasion, especially as these remarks contain some valuable advice to those who would avail themselves of the benefit of the patent law. It is, however, right to premise, that his lordship did not call upon the Company to produce their evidence, but was content with the information elicited by cross-examination of the plaintiff's chemical witnesses, and consequently fell into some slight inaccuracies as to facts. At the conclusion of the case, Sir F. Thesiger, who appeared for the London Manure Company, submitted that the specifications of both patents were void, for not being sufficiently precise, and for making claims which were too extensive; upon which his lordship interrupted him, and said:—

"My present impression is, that the first patent (Mr. Lawes') is entirely void, for at least six or eight reasons. At present I will only state one: that it claims the use of superphosphate of lime, derived from any other substance in nature that contains phosphate of lime, except bone and bone dust. It must be admitted, upon the evidence, that bone dust and bone had been used with sulphuric acid before this patent was taken out, and the consequence of that is, that the world, the public at large, were in full possession of the right to use bone and bone dust for the purpose of getting superphosphate of lime—a chemical substance, with definite proportions of lime and phosphoric acid, perfectly well known; and all the public had a right to use superphosphate of lime so obtained. In that state of things I am clearly of opinion, in point of law, that no man had a right, because he had discovered that superphosphate of lime could be obtained from apatite and some other substances, to take out a patent for the exclusive use of every substance in the whole compass of nature that would furnish it, except bone and bone dust. It seems to me to be really as great a violation of the spirit of the law of patents as I have ever met with, to come in, when the invention was already made, already in use, and say, 'The public use it from such and such things; I will now take out a patent for the use of it by anything else in the whole realm.' I am of opinion that it cannot be sustained. I think there are several other objections. In the second head of invention, the absence of the statement, whether you are to use the phosphate or the superphosphate is exceedingly important—and it is a fatal objection; and as to the third, it seems to me, that if common sea sand had been used, and the suggestion of using glass was in Liebig, the merely saying, 'now put Liebig's suggestion in practice,' cannot be made the subject of a patent. In all cases where what is called a suggestion has been used, it has been mixed up with some positive distinct invention, and not merely turning that which is suggested into use. Here the direction is, 'if your soil wants silica, then take some ground glass to it,' and Liebig said so some years before.

After some further observations on the part of counsel, his lordship proceeded to address the jury, and made the following remarks:—

"As far as the patent is for a mere process, supposing it to be for a mere process, in my judgment, in point of law it would be void. You cannot take out a patent *simpliciter* for a process. If you could suppose any combination of figures or angles in ploughing would produce an effect on agriculture, nobody could take out a patent for that, because the result is common to all the world—it is a mere mode. The patent law applies only to manufactures; but I think that the construction of all the courts would be, that although a thing was described as a *method*, yet if it really did end in the production of a distinct specific thing, that that was in reality a new manufacture, just as in the case of Crane *v.* Price, where the thing produced was *iron*, which had been produced by a different process over and over again; but the courts considered that it was not exactly the same kind of iron, there was some advantage, it was better in some respects, and therefore they considered it to be a *new manufacture;* and thus, although the patent was taken out for a method or *process*,

the patent was sustained; hut for a mere process, supposing it to be nothing hut a proeess, it is, I think, quite clear that a patent could not be sustained, the statute of James applying to nothing but manufactures. Now, the first patent (Mr. Lawes') is probably free from tbat objection; the second (Murray's), my impression at present is, may ultimately turn out to be free from that, inasmueh as one must always eonstrue every instrument of every kind, so that it may rather mean *something* than mean nothing; and I think one ought always to construe every patent, and every specification, in the most fair, liberal, and indulgent spirit, looking to see wbat language is used, and always endeavouring to make sense of it, and always endeavouring to make it consistent rather than the contrary. My grcund for thinking tbat tbe first patent is not sustainable is this, that it turns out *now* that the process of getting this superphosphate of lime from hones and crushed bones was perfcctly well known. The present plaintiff has merely done this—he has discovered that the same thing may be done from burnt bones, and the same thing may be done from apatite. I think considerable doubt might have been entertained whether the patent would have been good, if it had been limited to hurnt hones, or had been limited to apatite; for, after all, according to the chemists, you get the identical substance that you used before, witbout the slightest shadow of variation. But the claim to exclude the public from any further experiments, or any further use of anything else under heaven tbat contains these substances, seems to me very much too large in point of law, and one that cannot be sustained. It arises out of that whicb one very often finds, and which I lament very much when I do find it—tbe endeavour to spread your net so wide that it hreaks, and then you catcb nothing; an unfortunate circumstance to occur, but, I am sorry to say, it appears to me to have occurred here. On the second patent I think in the same way—that grasps at too much, but it contains nothing definite. No man, even a chemist, taking the second patent (Sir James Murray's), in my judgment, could make anything. The claim is this—without telling any person any particular substance, any particular acid, any particular mode of dealing with it, he claims, as it were, the prineiple of taking *any* acid, mixing it with *any* alkali, and tbrowing in *any* sort of absorbent or dry matter, like sawdust, earth, sand, and so on—he elaims that under any circumstances, with *any* acid, and *any* alkali, and in *any* proportions of any kind whatever. Very much too large a claim; because, in taking care to give a reward to those who really benefit mankind by distinct specific beneficial discoveries, one must take care that the law of patents is not made the means of preventing useful inquiry and research, and stopping the labour of others. By the grasping and taking to a supposed inventor discoveries tbat he never dreamt or thought of, instead of advancing the cause of science and useful industry, it is in reality closing up the door to future discovery, and enabling the supposed patentee to claim and take to himself much for which he never laboured at all. My direction tberefore to you, gentlemen of the jury, is generally to find a verdict for the defendants. Tbe other issues are of no importance; these issues go to the whole record. There are no damages to assess, tbe substance of tbe verdict being for the defendants."

The verdict was accordingly taken against the validity of both tbe patents elaimed by Mr. Lawes; but we underetand it is the intention of his counsel to tender a bill of exceptions to the ruling of the Lord Chief Baron, with a view of baving the question argued by the Court of Exchequer Chamber.

THE MECHANIC'S LIBRARY.

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RECENT PATENTS.

HYDRAULIC MACHINERY AND STEAM-ENGINES.

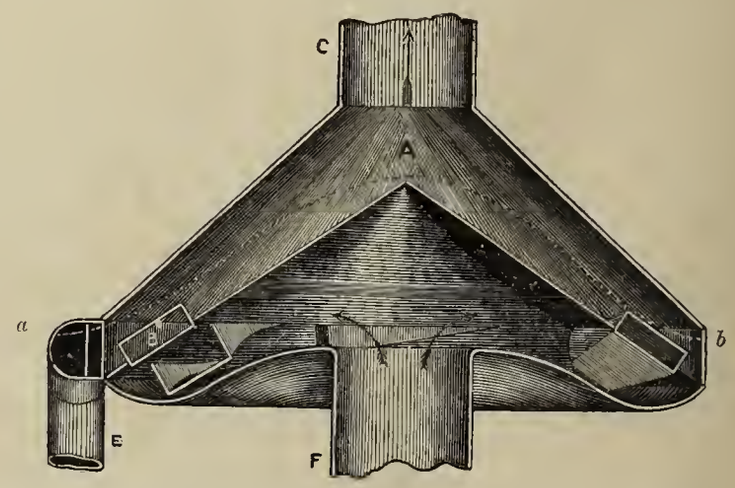
James Thomson, *Glasgow.—Enrolled Jan.* 3, 1851.

Tbe voluminous nature of Mr. Thomson's specification prevents our giving more than a general abstract of its contents. It comprises—First: Improved water-wheels for obtaining motive power from falls of water. Second: A centrifugal pump-regulator for ordinary water-wbeels. Tbird: An apparatus for obviating priming in steam-engines, especially in marine engines and locomotives.

The new water-wheels are of two kinds, very distinct from one anotber, although the elass of wheels called *turbines*, when taken in its widest range, includes them both.

The first kind, called hy the inventor his Case Wheel, is a turbine in which the moveable wheel is enclosed within a fixed case, the water being injected tangentially at the circumference of the case, and then passing through straight or curved radiating conduits in the wheel, and escaping at the centre by two orifices, one of whieh discharges upwards and the other downwards. Of this machine, one of the most essential features is, that the circumference of the wheel should move with the velocity which a heavy body would attain in falling through a vertical space equal to half the vertical fall of the water, or, in shorter terms, with the velocity *due* to half the fall; and that the orifices through which the water is injected into the case should be conjointly of such area, that when all the water required is flowing through them, it also may have a velocity due to half the fall. Thus tbere is no impact between the water and the wheel; hut, on the contrary, the water enters the conduits of the wheel gently, tbat is to say, with scarcely any motion in relation to their mouths. Since one half only of the fall is employed in producing velocity in the water, the other half still remains acting on the water within the case at the circumference of the wheel in the condition of fluid pressure. Now, with the velocity already assigned to the wheel, it is found that tbis fluid pressure is exactly that which is requisite to overcome tbe centrifugal force of the water in the whcel, and to bring the water to a state of rest at its exit, the mechanical work due to both halves of the fall heing transferred to the wheel during the combined action of the moving water and the moving wheel. In the foregoing statements, the effects of friction, and of some other modifying influences, are for simplicity left out of consideration; but in the practical application of the principles they must be taken into aceount, and the manner of doing so is laid down in the detailed explanations and rules given by the patentee.

Fig. 1.

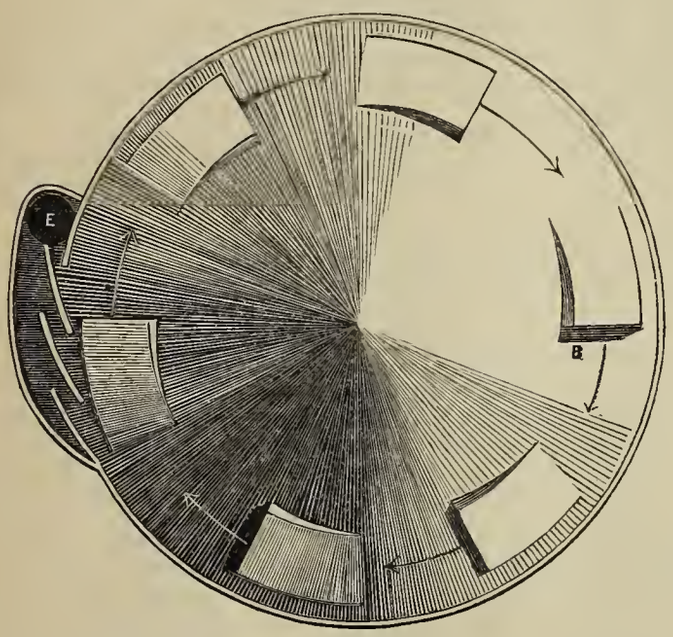


Tbe sccond kind of water-wheel is called by the inventor bis Suction Wheel, or his improved Danaide.* In this apparatus Mr. Thomson has adopted the principle applied in the French Danaide, and which, admirable as it is, has been left almost dormant since its first promulgation, never having been worked out in a good practical form.

* The name Danaide has been given in France to a particular kind of water-wheel, included in the general class of turbines, and having, as a prominent part of it, a circular vessel, or tuh, into which water is constantly poured, and from which it constantly escapes by a hole in the bottom. The name is taken from the Danaides, or the fifty daughters of Danaus, king of Argos, who, all except one, according to ancient mythology, murdered their husbands on the first night of their nuptials, and as a punishment for their crime were, after death, condemned to be constantly filling with water a vessel full of holes, through which the water ran out, so that their toil was endless.

Mr. Thomson's improvements are chiefly as follows:—The total size and the weight of the moveable wheel are greatly diminished by his substituting, in place of the lower part of the tub, a suction-pipe attached to the discharge orifice in the bottom of the tub at the centre. The water is introduced into the moveable wheel in a much more advantageous manner than it had been previously, by a peculiar form and position given to the injecting orifices. A self-acting regulator, which is essential to

Fig. 2.



the good performance of the wheel, is supplied in a simple and efficient mechanism. This wheel the inventor considers as being the best that can be used in most cases, when the fall is from about ten to about forty feet, and he regards it, in cases for which it is suitable, as being decidedly superior to the best of the ordinarily used vertical wheels.

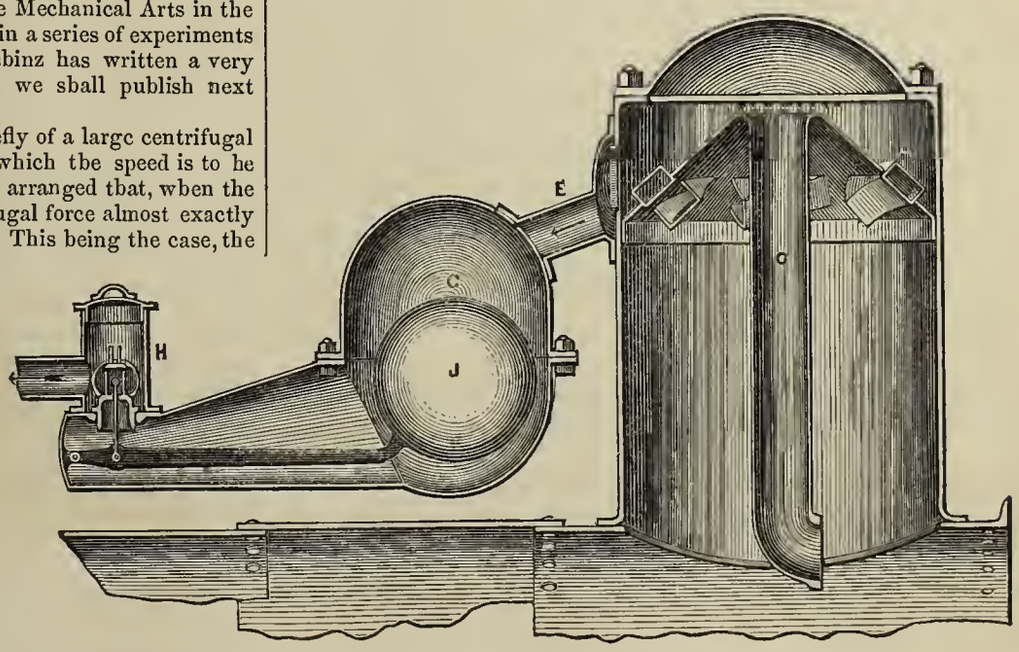
Dr. Schinz, Professor of Engineering and the Mechanical Arts in the University of Aargau, some time ago took part in a series of experiments made on this wheel by the inventor. Dr. Schinz has written a very favourable detail of these experiments, which we shall publish next month.

The centrifugal pump-regulator consists chiefly of a large centrifugal pump, driven by some part of the gearing, of which the speed is to be regulated, the connection of the pump being so arranged that, when the gearing is going at its proper speed, the centrifugal force almost exactly balances the gravity of the water in the pump. This being the case, the pump is kept usually throwing up only a moderate quantity of water; but when, from any cause, the gearing begins to go a little too quickly, the pump raises a much greater quantity, and thus occasions an increased resistance to the motion of the driving-wheel, and *vice versa*. The water elevated is simply allowed to fall back into the reservoir, or well, in which the lower end of the pump revolves. If a man be employed to take charge of the driving water-wheel, he should diminish the supply of water to it whenever the centrifugal pump is raising too much water, and he should increase the supply whenever the pump is raising too little. If, however, the supply of water for the driving-wheel be scanty, so that it must be economised, even at the cost of allowing the machinery to go occasionally too slow for a short time, he should keep the pump usually raising no water, but just on the point of raising it. The apparatus will thus be ready to check any excess of speed which may tend to occur. Instead of the man, a self-acting apparatus, such as that already referred to as being adapted by Mr. Thomson to his improved danaide, may be employed to regulate the supply of water to the driving-wheel.

A good apparatus for controlling the speed of large bucket water-wheels has been hitherto a desideratum, because, when the work they have to do is liable to sudden variations, their speed fluctuates to a very prejudicial extent, or, in other words, they are liable sometimes to take "races," and sometimes almost to stop.

The last branch of Mr. Thomson's invention is his apparatus for obviating the bad effects of priming in steam-engines. The manner in which the water carried up along with the steam is removed from it, is as follows:—The steam is made to blow into a circular vessel tangentially, at or near the circumference, and passes away from the vessel at the centre. The steam and water in the vessel are thus subjected to a rapid whirling motion, and the water flies outwards by the centrifugal force, and passes off by an aperture or apertures at the circumference. The apparatus may be applied to the engine in various situations, according to convenience, or to the purpose to be served. Thus it may be applied to the steam-pipe either without or within the boiler, and it may be applied at the top, or at any other part of the waste steam-pipe. Figs. 1 and 2 represent it as it would be applied to a vertical pipe through which the steam ascends. Fig. 1 is a vertical section, and fig. 2 is a plan in section along the line *a b*, in fig. 1. Through the explanation already given, and by reference to the arrows on the figures, it will be seen that the steam is injected into the circular vessel, A, tangentially through the orifices, B; that, therefore, it must exist in the vessel in a whirling state, and that it passes away by the pipe, C, from the centre of the whirl. The water leaves the vessel by the orifices, D, at its circumference, and is conveyed by a pipe, E, to any required place. If, for instance, F and C be parts of the steam-pipe leading from the boiler to the cylinder, and the vessel be placed sufficiently high above the level of the water in the boiler, the water may be allowed to descend into the boiler by its own gravity through the pipe, E, which would then be made to terminate in the boiler near its bottom. When this arrangement is adopted, a valve opening towards the boiler may be found requisite in the pipe, E, to prevent regurgitation of the water. Another arrangement for disposing of the water is represented in fig. 3, and will be explained when that figure is described. Again, if the apparatus is placed on the waste steam-pipe of a marine engine, the pipe, E, may convey the water into the paddle-box; and the escape of a little steam along with the water will not be detrimental. In locomotives, the apparatus should be placed within the steam-chest, as represented in fig. 3, where A is an upper compartment of the steam-chest, in which the steam exists in its whirling state, after having passed through the tangential orifices in the conical diaphragm, shown in the figure at the top of the steam-pipe, C. The pipe, E, conveys the water, after it has been separated from the

Fig. 3.



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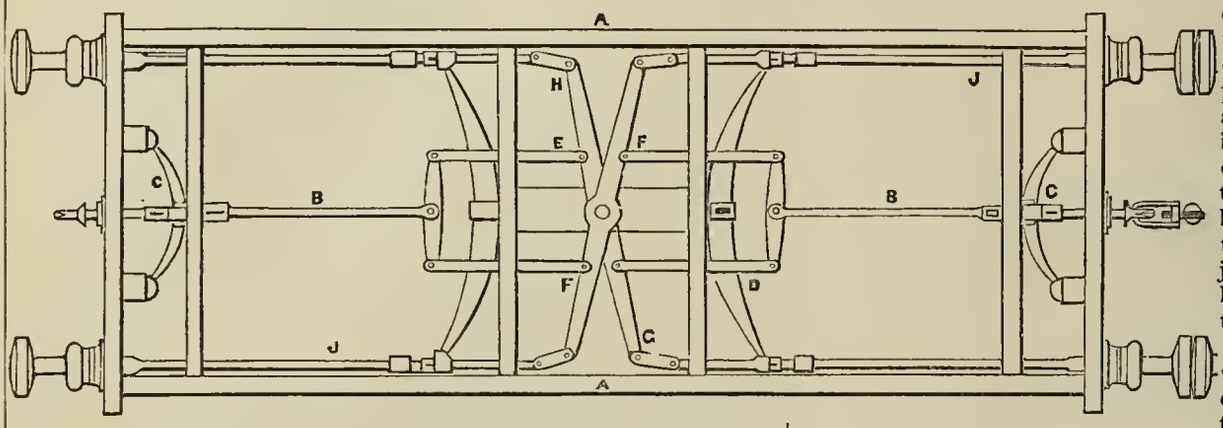
steam, to a close cistern, G, from which it is allowed to escape by an equilibrium valve at H, whenever so much of it accumulates as to raise the float, J, connected with the valve by a lever and a link. The water, having escaped through the valve at H, may be led either to the tender or to the pipe which supplies the feed-pump, so as in the end to be returned to the boiler. The method also of allowing the water to return to the boiler by its own gravity, without applying the close cistern and float, would be applicable in locomotives, provided that the tangential orifices in the diaphragm be not made too small.

RAILWAY CARRIAGES.

T. Merchant *and* R. Harland, *Derby.—Enrolled Dec.* 25, 1849.

All railway travellers must have observed the extensive amount of oscillation to which carriages are liable when coupled together, so that the buffers of one carriage are not in close contact with those of the adjoining carriages; and to such an injurious and alarming extent is the rocking often exhibited, that it is no uncommon occurrence for passengers to request the guard to screw up the couplings; and if that can be done, the rocking motion of the carriage is very much subdued, and the journey is continued with comfort. This, however, cannot always be done, for it frequently happens, especially if the train be heavy, that the coupling is found to be sufficiently tight when the train is at rest, or that it has already been screwed up to the limit of the screw, and consequently an injurious pressure is constantly acting upon the draw-spring, whether the train is in motion or at rest.



The object of the first part of these improvements is to prevent this rocking of the carriages, by keeping the buffers constantly in close contact. This is effected by connecting the buffers with the draw-bars, in such a manner that the buffers of each carriage slide out with the draw-bar in any given ratio, so as to keep them constantly in close contact with the buffers of the adjoining carriages when the train is in motion, and relieve the draw-springs from undue pressure when the carriages are at rest; so that, when the carriages of a train are connected together according to this mode, the rocking to which they are liable (and which is very extensively destructive both to the carriages and permanent way, and alarming and dangerous to passengers) is much diminished.

Our engraving represents a plan of the frame of a railway carriage. The outside framing, A, does not differ from the framing of ordinary carriages; B, is the draw-bar by which the carriages are attached to one another, or to the engine; C, is the spring by which the draw-bar is brought back to its position, after the pressure by which it was drawn out is removed; D E, are connecting-rods or arms attached to the draw-bar, B, by joints at F; G and H, are two levers turning upon a central pin which is attached to the framing. One of the connecting-rods is attached to the lever, G, and the other is connected with the lever, H. The buffer-rods, J, are jointed, as represented, to the ends of the two levers, G H.

When the force by which the train is put in motion first acts on the draw-bar, the spring, C, yields, and the draw-bar is drawn out. As the draw-bar moves, it communicates motion through the connecting-rods, D E, to the levers, G H; and these levers thrust forward the four buffer-rods to which they are connected. The buffer-rods moving simultaneously with the draw-bar, the buffers of each carriage are maintained in close contact with those of the adjoining carriages, and the whole train is tightly coupled together. In our sketch, the connecting-rods are represented as being jointed to the levers, at such a point that any given motion in the draw-bar will communicate three times that range of motion to the buffer-rods. But this ratio of motion may be either increased or diminished, by connecting the rods with the levers at points nearer to, or farther from, the centre on which the levers turn. It will be seen that the links which connect the buffer-rods to the levers are not connected therewith by a simple joint, but that there is a slot in each of them, in which slot a pin in the end of the lever works. The object of this construction is as follows: When the train is moving on a curve, it is necessary that the buffers on the convex side of the curve should be forced out, whilst those on the concave side should be capable of retiring; when the pressure against the buffer-rod is greater than the resistance of the buffer-spring, the pin in the lever moves on the slot in the link, and does not push the buffer forward.

The patentees show various plans for connecting the buffers with the draw-bars. In one of these arrangements, the object is effected by introducing the cross levers near the end of the carriage. The same end may be effected in a great variety of ways: for example, the draw-bar may be dispensed with, and the buffers securely connected together by any suitable coupling; the buffers being connected to whatever drawing apparatus may be used, in such a manner as to keep the buffers of one carriage in close contact with the buffers of the next one, under all circumstances of traction, as changes of velocity, inclinations, &c., whether the train be moving in a straight line or in a curve; thus effecting a system of parallel traction throughout the train, instead of the carriages being drawn by a single link, attached to the centre of the ends of each, and allowing the buffers to become separated by the tractive force employed in moving the train, as is the case with carriages of the ordinary construction.

The remaining portion of the specification refers to a modification of the common double wood-block railway brake, and to what the inventors have named an improved "mercantile carriage." The brake is made in the usual way, with a couple of curve-faced blocks pressing on the wheels, and actuated by a double lever, having connecting-rods passing to each; the only novelty being in the mode of carrying the brake blocks. Instead of linking them to the carriage framing, they are jointed on the lower side to the longitudinal bar, which connects the two bearings of the wheels.

The "mercantile carriage" embodies a plan, by which the cover is more easily removed than by the existing plans. This is accomplished by setting the cover on a centre pin; the opening being effected by turning the cover on this centre, instead of working it in slides or on hinges.

The improved brake offers some advantages in point of simplicity and durability, and the cost is said to be less than that of the old plan, by one-third. It has been fitted to about twenty vans on the Midland line.

The patentees are also about completing eight first-class carriages, with the new buffer apparatus, for the Midland Company. We shall probably be able shortly to give the particulars of an experimental trip with them.

PREPARATION OF TEXTILE MATERIALS.

Elijah Slack, *Renfrew.—Enrolled Dec.* 2, 1849.

The very valuable improvements comprehended under this patent, have reference to the treatment of textile materials of the flax and hemp kind, for the more effectual removal of the resinous or gummy matter, and the separation of the ligneous portions from the valuable fibres. Amongst the materials enumerated by the patentee, as suitable for his peculiar treatment, are the common flax, hemp, jute, Kentucky, Russian, and Italian hemp and grass, and China grass; but all other fibrous plants appertaining to the same family, may be judiciously worked in the same manner. The object in view is the obtainment of a finer, more ductile and silky fibre, than can be produced by the ordinary means, together with the power of working up and turning to valuable account the coarser and originally less valuable materials, either raw or in a partially manufactured state. Amongst the latter are the sheets and bags imported into Great Britain, as cases for packing cotton, sago, rice, and sugar.

The materials to be treated are placed in water, heated to from 80° to 120° Fahr., in order to assist the primary separation of the dirt and foreign matters. This steeping action is continued for several hours, after which the water is drained off, and the materials are then immersed in a boiling solution of lime, from one to two and a half pounds of lime being used for each hundred pounds of materials; or in place of the lime solution, a caustic or other alkaline solution, of a strength equal to from 1° to 3° of Twaddell's hydrometer, may be employed. After boiling some hours, the materials are washed in clear water. The effect of this lime, or caustic alkaline treatment, is to separate or subdivide the fibres and remove the gummy matter, so as to bring it to a proper condition for bleaching and decolourising, by immersion in a solution of chloride of lime. The solution employed for this purpose is of such strength, that from one and a half to two measures of it will change to a yellow colour one measure of the bleacher's blue test liquor. After steeping in the chlo-

ride of lime solution, the materials are passed into a solution of sulphuric or muriatic acid, and finally washed. If necessary, the whole of these processes are to be repeated, until the mass has been thoroughly and uniformly operated upon, or until the required fineness of fibre has been obtained. When this fineness is satisfactorily arrived at, the materials are boiled in an oleaginous solution, compounded of two gallons of gallipoli, or other suitable vegetable oil, to one gallon of caustic potash, of a strength of 15° Twaddell, two quarts of such mixture being used for each hundred pounds of materials. Instead of this, a solution of black or other soap may be used, the object being to improve the flexibility and silkiness of the fibre.

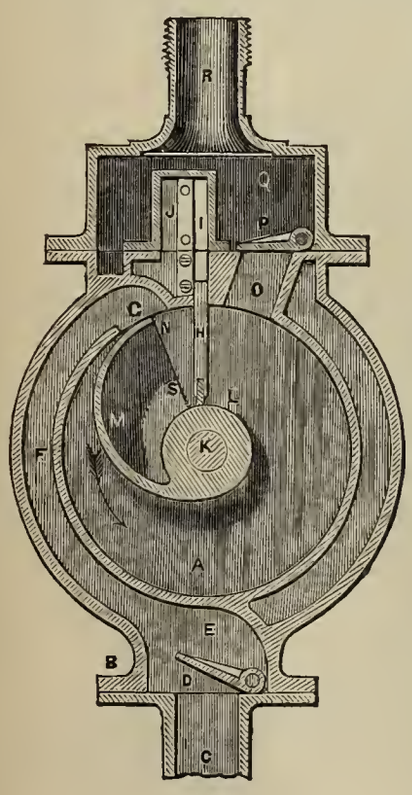
By this process Mr. Slack is enabled to produce a beautifully fine and silky fibre from even the coarsest materials. The specimens which we have seen are far superior to any of the so-called preparations of "flax cotton;" indeed the fibres very closely resemble those of a glossy ductile silk.

REGISTERED DESIGNS.

ROTATORY PUMP.

Registered for Mr. Thomas Clunes, *Brassfounder, Aberdeen.*

Mr. Clunes' "rotatory pump" bears a strong resemblance to—and is indeed a modified form of—a well-known class of rotatory steam-engines, where an eccentric revolves inside a cylindrical case. The engraving is a vertical sectional elevation of the pump in working order, as constructed to deliver 60 gallons per minute, the scale being $\frac{1}{8}$th the real size. A, Is the working cylinder or pump-case, being a short cylinder placed with its axis horizontal, and supported on a flanged base, B. This flange is bolted to a corresponding flange on the vertical supply-pipe, C, the end of which opens directly beneath the clack-valve, D, in the chamber, E, leading into the external channel, F. This channel terminates in a port, G, on the upper side of the cylinder, and immediately behind the vertical sliding-stop or diaphragm, H. This stop is fitted to slide vertically in the groove, I, covered by the case, J, to keep it tight; and its lower edge, faced with leather or other elastic material, rests for the greater part of the revolution of the shaft, K, upon the cylindrical boss, L. The driving-shaft, K, is passed horizontally through one side of the cylinder by a stuffing-box, and its opposite end rests in a closed bearing in the other side. The boss, L, extending across from end to end of the cylinder, is fixed upon the shaft, and is cast with an eccentric or spiral cam, M, the outer end, N, of which, works in contact with the interior surface of the cylinder, whilst its sides are in contact with the cylinder ends. O, Is the delivering-port, opening out at the top of the cylinder, just in front of the diaphragm, H, and governed by a clack-valve, P, in the delivery-chest, Q, having a discharge branch, R, for the fluid. When in action, and when the straight line, S, of the cam has passed, so as to allow the diaphragm, H, to fall, the revolution of the cam causes a vacuum behind it in the cylinder, after passing the inlet-port, G, and thus elevates a supply of water to the cylinder through the bottom clack. At the same time, the water already in the cylinder, in front of the eccentric, is driven out by the latter through the upper valve, P. As the eccentric approaches the diaphragm in its revolution, its volute curve gradually elevates the diaphragm, which again drops upon the boss, L, to act as the stop for the fluid. This gradual curve of the cam produces a smooth and easy action on the diaphragm, whilst the quick revolution of the cam gives a uniform continuous fluid discharge. The pump has no parts which are liable to any serious derangement, and for that reason it is suitable for the farmyard or manufactory, whilst its neat external appearance claims for it a place in domestic establishments, where the ordinary pump mechanism might be a disfigurement.

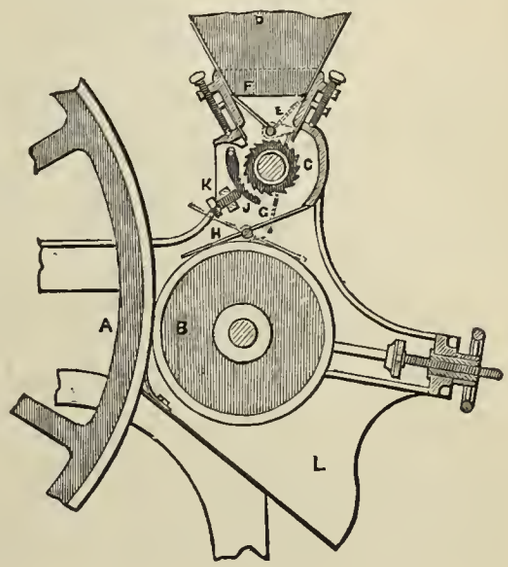


1-8th.

ROLLER-MILL.

Registered for Messrs. E. R. Turner & Co., *Engineers, Ipswich.*

The roller-mill for crushing grain and linseed, introduced by Messrs. Bond, Turner, and Hurwood, the predecessors of Messrs. Turner, has now been for some years in general use amongst agriculturalists, but a ready means of adapting it to grind beans has long been wanted. This is now very simply accomplished by the roller-mill now before us. Before describing the improvement, it is necessary, for the information of those who are unacquainted with the original roller-mill, to state, that by it the grain is crushed between two smooth iron rollers of different diameters, the smaller one being about one-sixth the diameter of the larger. The spindle of the large roller has a hand-crank attached, by which it is turned, and the feed is regulated by a small fluted roller at the bottom of the hopper, driven by a strap from the small crushing roller. The feed roller is made the grinding roller for beans. Our engraving gives a vertical section of the mill, on a scale of 1-12th real size. A and B, Are the ordinary crushing rollers; upon the spindle of the roller, B, is placed, externally, a toothed wheel, taking into and driving a similar wheel on the spindle carrying the serrated roller, C, which acts as a common feeding roller, while the mill is used for crushing corn. At the bottom of the hopper, D, there is a moveable lip, E, by which the course of the grain may be directed to either side of the roller, C. The lip, E, is moved to either side by means of a lever, F, connected to the spindle of the lip on the side of the hopper, opposite to that on which the wheels work. To this lever is attached a rod, G, connecting it with another lever on the spindle of a guide-spout, H, which is thus reversed simultaneously with the lip, E. After using the mill for crushing corn, in order to adapt it for breaking and grinding beans, it is only necessary to turn the lever, F, from left to right, and turn the wheel, A, in the opposite direction, when the beans, falling between the serrated roller, C, and a corresponding face, J, adjustable by a screw, K, are ground, the meal being directed by the guide-spout, H, over the small crushing roller, B, into the delivery-spout, L.



1-12th.

The details of this mill evince great care in the arrangement and fittings. It is a most useful machine.

FOUR HOLE BUTTON.

Registered for Mr. J. W. Smith, *Birmingham.*

Mr. Smith's improved "four hole button" professes to remove, or at least mitigate, what every one must have felt as a most serious source of discomfort—the giving way of buttons. Fig. 1 is a plan, and fig. 2 a transverse section of the button. The disc of the button is dished in the usual way, and the thread-holes are disposed triangularly, with an additional large one in the centre. In attaching this button, the thread is passed through the centre hole each time it is entered through the remaining three. In this way a species of central shank of thread is obtained, giving a greatly increased strength to the connection.

Fig. 1.

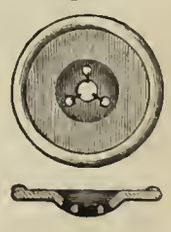
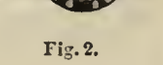


Fig. 2.



FEED REGULATOR FOR MILLS.

Registered for Mr. J. Smith, *Uxbridge.*

The improvement which Mr. Smith has introduced for grinding-mills, has reference to the securing perfect regularity of feed, whatever extent of opening may be allowed at any given time.

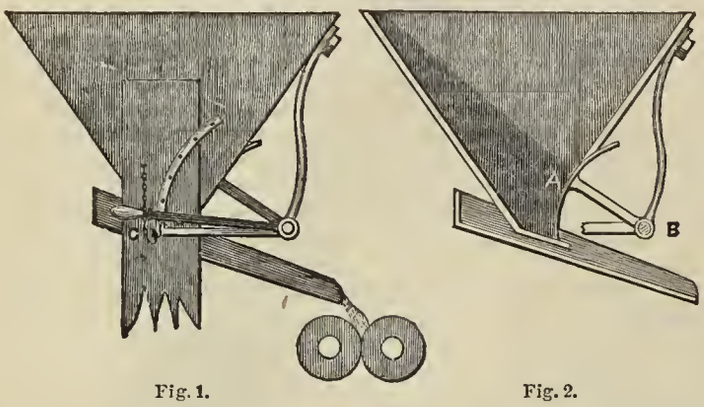


Fig. 1. Fig. 2.

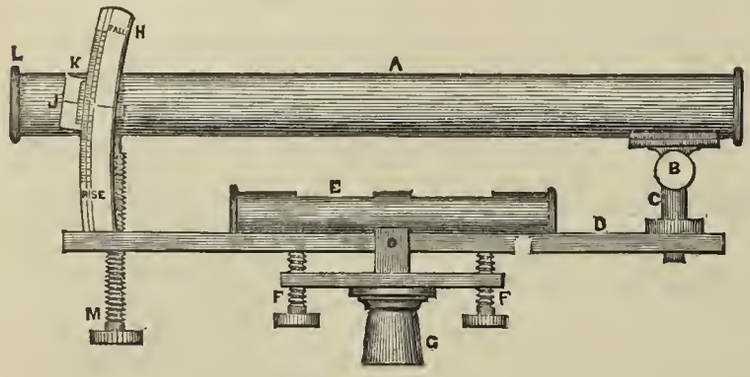
Fig. 1 of the engravings represents an external elevation of a mill-hopper, with the regulator and feed-slide attached, and fig. 2 is a corresponding vertical section. The regulator is at A; it is a segmental plate, attached by one or more arms to the shaft, B, the convex side forming the regulating stop for the material in the hopper. The effect of this curved plate is to give a constant parallel movement, however long the feed aperture may be.

It may be applied either inside or outside the hopper. The external view shows how the amount of opening is indicated outside, by the position of the adjusting lever, C, on the quadrant-holder.

DRAINAGE LEVEL.

Registered for Mr. T. R. Gardner, *Optician*, 21 *Buchanan Street, Glasgow.*

Mr. Gardner's "drainage level," is a simple and effective self-recording instrument, suitable for levelling drains, sewers, or roads, or for measuring the elevations and depressions of ground. Our engraving represents a complete side elevation of the instrument, one-fourth the real size.



A, Is a telescope of the ordinary construction, hinged by a joint at B, to a stud-pin in the top of the short pillar, C, carried on the surface of the horizontal level plate, D. This plate has fitted to it a spirit-level, E, for adjustment to the horizontal position in the ordinary manner, by the inverted adjusting screws, F F, and the whole apparatus is fitted by means of a pivot or centre joint, G, to the usual tripod stand. H, Is a segmental graduated scale, set upright on one end of the level plate, D, the curve being struck from the centre of the joint, B. The zero of this scale is at I, in a line coincident with the horizontal axial line of the telescope; and an index, J, is carried on the side of the telescope on a vernier, K, for subdividing the graduations. The index figures of the graduations read upwards and downwards from zero, and are so proportioned as to show the amount of rise or fall per 100 feet of the horizontal distance, when the sight end, L, of the telescope is depressed or elevated, to bring the object into a line with the cross hairs by the adjusting screw, M. In using this drainage level, the plate, D, being first levelled by the spirit-level, the telescope is brought to bear upon the object by the screw, M, when the index on the telescope at once records the amount of rise or fall, in feet and inches, per 100 feet.

The graduations on the scale, H, are read as feet, subdivided to six inches; the index figures running from zero, in direct arithmetical progression, 1, 2, 3, &c., up and down, to the extent of the instrument's range. In the hands of even the most unlettered farm-servant, this little instrument will afford the most correct measurements, as the operator has only to level the plate, D, and bring his sight to bear on the object, when the elevation or depression is given at once. It will be a most useful contrivance for draining or road-making.

CORRESPONDENCE.

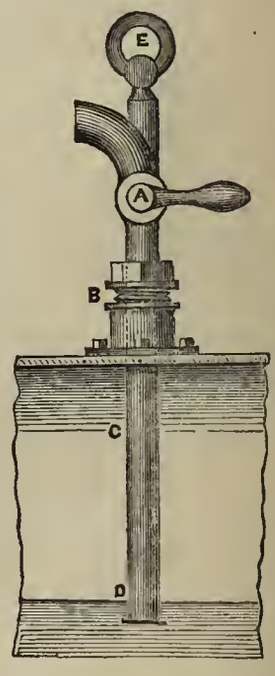
APPARATUS FOR CHANGING THE POSITION OF CARRIAGES ON RAILWAYS.

In the last number of the *Practical Mechanic's Journal*, I find you have given some particulars of a patent for this purpose, in the name of Messrs. Ormerod and Shepherd of this city. Now, you must be aware that I was the first person who invented a traverser to carry the weight on the lower edge, or on the wing of the frame or beams, as specified under my patent of November, 1847, for "Improvements in the manufacture of railway wheels and axles, and machinery and apparatus for placing carriages on to a line of rails, for removing them from one line of rails to another, and for turning them." The section of the frames employed to carry the shifting parallel rails was described and claimed in my specification, as an improvement for bringing down the rails of the traverser so near to the permanent rail, as to admit of the use of a gently inclined plane for the ascent and descent of the carriage during removal. My object in drawing your attention to this point, is to enable you to judge of the conduct of Messrs. Ormerod and Shepherd, who, you will find, have patented, and introduced as a new invention, the very same plan as mine. I may add, that my arrangement has met with the most complete success in its very extensive applications on the railways both of this country and the continent. Thomas Dunn.

Manchester, January, 1851.

STEAM BOILER WATER GUAGE.

I beg leave to enclose you a sketch of a water-guage for steam boilers, which, I find, indicates the water-level much more truly than the fixed steam and water-cocks usually employed. It shows the exact height of the water, while the other has a range equal to the difference of the length of the two guage-tubes. With two fixed guage-tubes, the water may be within one-eighth of an inch of the bottom of the lowest tube, and yet blow water, the engineer having thus no means of knowing whether the water is nearly up to the steam-guage, or at the lowest level to which it can safely fall. With the enclosed it is different, the engineer having only to move it up or down, to know the exact height of the water in the boiler.



It is simply a guage-cock and tube working in a stuffing-box, fixed to the boiler top; A, is the cock, B, the stuffing-box, C, the guage-tube, descending some inches below D, the water-level, E, is a ring by which to move the guage up and down.

R. D. E.

Greenock, January, 1851.

THE REACTION SYSTEM OF STEAM-BOAT PROPULSION.

On reading, in your last *Journal*, Part 34, the letter on a gravitation propeller, I was struck with the idea that Ruthven's invention seemed to be the only one known of that class. I now ask you if Mr. Ruthven ever tested his invention on a scale by which practical results can be obtained? or if, after all this parade of superiority which has appeared in different journals, it has nothing else to recommend it but proofs on paper? I have carefully read Mr. Ruthven's specification throughout, accompanied by an experienced man, well qualified to judge, and it is his opinion, as well as my own, that, if put into practice, according to the arrangements laid down in that specification, it would prove a very sorry affair, after all that has been said to the contrary.

You will perhaps remember having stated, that you could not see the difference between Mr. Ruthven's propeller and ours, except in minor

detail. Now, in the first place, the revolving apparatus is widely different. Ours is an adaptation of Appold's centrifugal pump. Mr. Ruthven's pump will not do near the duty of Appold's, and why should it do more as a propeller? Mr. Ruthven has so elevated his water, as you remarked to your correspondent, A. B., by which he loses much power; but, on the contrary, has a certain column of water to assist the motive power. After leaving the propeller, the water, in Mr. Ruthven's arrangement, circulates through a range of pipes with bends at right angles; the water striking these curvilinear bends, added to the friction of passing through a length of pipe, is another loss we do not sustain, for the revolving apparatus of our propeller may be said to lie in the open water. It is clear, that the pressure generated in the case of the propeller, would cause the water partly to return from where it entered, were it not for some provision to the contrary. Mr. Ruthven accomplishes it by means of India-rubber rings, adjusted by screws to the orifice of the inlet of the revolving apparatus; we, by bringing a metallic surface as near as practicable to the inlet of the revolver, without touching. Practice proves to us, that the leakage by this plan is not to be detected. Then why clog the machine with a break, the loss of power from which must be enormous? The inlet of Mr. Ruthven's apparatus, which forms the bottom of the vessel, is the most curious part of the whole affair, and I have never seen it anywhere mentioned but in the specification. It is made in the bottom of the ship, in the form of a very long tank; according to his drawings, about one-fourth the length of the ship, and one-third the breadth, perhaps one foot deep. At the bottom, or outside, of this tank, are perhaps 200 holes of a very peculiar form, so contrived as to catch the water when the ship goes forward. Mr. Ruthven states, that here another power tending to propel the vessel, by the water being sucked in through these openings, will be the result. I ask, why use all these openings, whose united area will amount to twenty times as much, or more than the inlet of the propeller? I should suppose it is intended to increase the *sucking surface*. This much I know, that the velocity of the water entering these holes being much slower than the velocity of the boat, will offer a highly resisting surface, and operate much like barnacles, or grass growing on a ship's bottom. Mr. Ruthven has patented his invention solely to discharge the water above the water-line, and we to discharge below it. Many other differences there are between us, which it is not important for us now to mention.

Now, if Mr. Ruthven has not tried his invention, we have, and can therefore offer the public some solid information upon this system of propelling, viz., that patented by Messrs. Callaway & Purkis, 24th May, 1850, and the first of the kind that has ever been published, to our knowledge. The boat we built for the occasion is 25 feet long by 4, and 3 feet 6 deep, and is framed of iron, covered with tin-plate. She carries engines and boiler weighing about 12 cwt., and can accommodate eight persons; but on account of the boiler in so small a boat being necessarily above the water-line, she is what is termed cranky, and not safe enough to carry more than six. The water and coke will bring her to two tons; her shape is very sharp under water, the wave principle being adopted; but it is spoiled by her weight making her draw so much water, 2 feet 3 inches, being more than the river steamers. The result of different experiments gives the following:—

Length of boat,	25 ft.
Breadth midships,	4 "
Depth,	3 " 6 in.
Draught,	26 "
Weight,	2 tons.
Cross sectional area of boat, measured midships,	821 sq. in.
Area of propelling surface,	15·5 sq. in.
Proportion area of boat, measured to the area of the propeller,	$\frac{1}{0}$
Power of engines about	2 horse.
Diameter of propeller,	7 in.
Annular opening between the discs of the propeller,	$\frac{3}{4}$ "
Diameter of inlet to propeller,	4 "
Revolutions of propeller per minute,	810.
Water discharged per minute by one propeller,	318 gals.
Would discharge, at its maximum velocity,	490 "
Speed of jet discharged,	11 miles per hour.
Speed of boat at present obtained,	8 miles per hour.
Width of propeller,	4 inches.

The water in this boat is discharged downwards, at an angle of 10 deg.; the jets are 7 inches apart, and parallel with the keel; the orifices 7 feet from the stem-post, and 9 inches from the keel. From this you see some very startling facts: the foremost is the smallness of the propelling surface required; and the size of the propeller itself, compared with others, is quite insignificant. Its weight, perhaps, does not exceed four pounds. All the minor parts of a marine engine are done away with, because the propeller always revolves one way, either the forward or backward motion, and the ship is brought to a stand-still without stopping either propeller or engines. All the working apparatus of the ship has nothing to do with, and is entirely disconnected from, the engine, and is managed by one man on deck, whose stand may be close to the commanding officer. These things are facts that can be seen at Putney any day; and have been exhibited frequently to those who have been desirous of seeing the boat. I now ask you, what the speed of our boat would have been, had she drawn 15 inches of water less than she now does? I am at a loss to find any rule to calculate the difference. Will you oblige by stating what it may have been, according to the build of the boat—one foot to 15 inches ought to have been the utmost draught at any time. If I mistake not, your pages are open to any man that can throw light upon any scientific inquiry, and especially on one of this class, that cannot be determined without a great outlay of time and capital. If such is the case, will you let your scientific readers know how far this much-talked-of mode of propelling has, in practice, actually progressed?

Railway Station, Putney, January, 1850. ROBERT PURKIS.

CORROSION OF CAST-IRON PIPES.

Can you, or any of your correspondents, inform me how many years cast-iron pipes laid to convey water through towns will last? This will, no doubt, depend upon the thickness of the metal, &c. But suppose we say a 2-inch pipe required to sustain a pressure of 220 feet, having a thickness in barrel of $\frac{5}{16}$ inch. The qualities of water and metal may also have some influence in determining their durability. Can you furnish instances of iron pipes having corroded so much as to require replacing? if so, what thickness were they? of what quality of metal? how long laid? was the supply constant or intermittent? and what quality of water conveyed? The thickness given to cast-iron pipes for the conveyance of both gas and water is much greater than what is required to sustain the pressure. An extra thickness was formerly given to compensate for the difficulty that there existed of making the inner and outer circles concentric. By patent and other methods the barrel is now made of nearly uniform thickness and density—pipes are now, in consequence, cast lighter. Yet they are much heavier than requisite to sustain the necessary pressure and shocks. This extra thickness, it appears, is given to allow for corrosion.

I have been informed somewhere, by somebody, that the gas pipes laid some years since in Glasgow, were cast very thin—that, in a very short time, they were so corroded from the exterior as to require replacing with others. I have further been told (but do not vouch for the accuracy of the statement), that iron mains were laid in Oldham for the conveyance of water, but that, owing to the quality of the water, they were in a very short time so far internally corroded as to need taking up, and that lead pipes were laid in place of them. If this be correct, it is important to learn what is the quality of the Oldham water.

Pure water, in passing through lead pipe, is known to become poisonous, from becoming impregnated with lead. On this account it is desirable to obtain a pipe suitable for services, and, of course, free from this important objection. Can you inform me if the "patent welded wrought-iron tubes" are suitable for this purpose? Would wrought-iron tubes, under equal conditions, corrode more than cast-iron? If the water was partially impregnated with iron, so long as it was not rendered unpalatable, it would not be objectionable, but would these wrought-iron pipes be durable? Perhaps you can tell me what kind of service-pipes are laid in Aberdeen, where the water is unusually pure, being only one degree of hardness, according to Dr. Clark's soap test.

Wrought-iron is considered to rust more readily than cast-iron when exposed to the atmosphere and wet; but whether such will be the case if buried in the earth, or in constant contact with water, is another thing, which I am anxious to get informed upon. Stirling's patent method of toughening cast-iron by the admixture of scrap-iron, seems an excellent means of increasing strength: but would not water pipes so made corrode more rapidly than if of cast-iron only? A. S.

ON STEAM-BOILER EXPLOSIONS, AND SOME NEWLY-DISCOVERED PROPERTIES OF HEAT.

III.

In arriving at the foregoing paradoxical conclusions, we have been led to, and strictly guided by, the indications of the different instruments employed, and by practical experiments upon working engines with these different kinds of elastic fluids as sources of motive power—our intention being to elicit useful truth—we therefore give full details, however singular it may appear, and certainly it does appear singularly

curious; for though we consider it unquestionable, that invariable atomic equivalents of water and heat constitute steam of all densities and temperatures, and we must therefore rationally and of necessity expect that other proportions of heat and water must constitute another fluid distinct from steam, still it seems hardly possible to conceive that so nearly similar quantities of heat and water, merely from the union thereof under different circumstances, should constitute so different and distinct an elastic fluid as we have found it to be; yet we shall find the paradox not only confirmed by other experiments, but by a practical, experimental application of these distinct combinations of fire and water for the production of motive force, under circumstances designed for and admitting of the strictest investigation, and seemingly of an unquestionable nature, and notwithstanding the following unexpected discovery.

For being up to a late period unacquainted with, and not suspecting any influence of mercurial vapour or fluid mercury upon heated steam in the foregoing experiments, particularly as we had experimentally proved that no mercurial vapour is formed from dry mercury heated to 660° within a glass tube under atmospheric pressure only; and again, when a volume of dry atmospheric air was confined by mercury within a glass eudiometer, it required about 480° of heat to double the volume of air confined therein. These joint results at first prevented our suspecting, and then for some time hindered our crediting, that the vapour of mercury any how interfered with the volume of steam in our experiments.

Notwithstanding this confidence, we found that mercury, or its vapour, exerts both a great and surprising influence on the volume of heated steam in our former experiments; because the behaviour of heated steam is so different when confined by fusible metal, or by linseed oil, instead of mercury, in similar tubes, that there can be no doubt the volume of steam is greatly affected when heated in contact with mercury, and also very differently affected thereby at different temperatures when in contact therewith, the volume of steam being much lessened from 228° to 250°, little affected thereby at 500°, and greatly increased in volume at 600° and upwards; yet, from a full comparison of this with other experiments presently detailed, wherein fusible metal or linseed oil were substituted, we are enabled to prove, though the rate of expansion is much altered by mercury, the total expansion of steam remains little altered thereby in the whole range of temperatures from 250° to 650°.

For when metal, formed of bismuth 5, of lead 3, of tin 2, fusible at about 210°, was employed to confine steam when heated within the same glass instrument to 650°, accompanied with a thermometer within a bath of fusible metal, then, when the apparatus was subsequently allowed to cool, the corresponding descents of the fusible metal and thermometers consisted of equal decrements for equal degrees of heat, showing a great difference in the rate, and but little difference in the extent, of the whole contraction of the steam from 650° to 250°, and that little difference will nearly vanish when the subject is further investigated and more fully explained.

As these experiments were carefully made with the same identical instrument, well rinsed in nitric acid, by merely employing mercury in one experiment, and fusible metal in another, the actual volume of steam employed in each case being produced under atmospheric + the pressure of the metallic column of 12.50 inches, the included volume of steam was therefore denser under the mercurial column than under the column of fusible metal, in proportion to the specific gravity of the respective metals, or as 13.58 :: 9.6. Therefore, as 13.58 :: 9.6 :: 12.50 :: 8.88; that is to say, the column of fusible metal of 12.50 is only equal in gravity to a mercurial column of 8.88 inches. Then as 42.50 :: 38.88 :: 6.8 :: 6.2, the volume of steam found under fusible metal, which will be found to correspond so nearly with the reduced scales of the experiments, which will presently be given in diagram No. 4, proving clearly that the expansion of steam by heat is so nearly alike in extent in both cases, that it may be considered the same for the general purpose of this work, and in which it would be useless to divert the attention for a moment from the great and valuable matters under consideration to trivial and valueless minutiæ.

This experiment with fusible metal would have been conclusive of the true and full rate of expansion from 212° to 650°, were it not for a very unexpected contingency; though the metal was completely fusible at 210° at commencement of experiment, yet, at its termination, the metal became so sluggish and pasty at 218°, that no lower temperature could be profitably observed thereby.

We attempted to discover whether the cause of this anomaly might not be found in the escape of some volatile metallic matter from the initial compound metal, when subsequently heated to 650°, by heating a small quantity of fresh metal from 60° to 650° within a long, open, cold glass tube, sealed at lower end only; but as no metallic or other vapour was observed to condense therein, we are unacquainted with the cause of the lessened fluidity, for no metallic vapour was observed to condense in the long cold part of the tube, nor could any other visible alteration of the metal be discovered on cooling, but lessened fusibility at 220°.

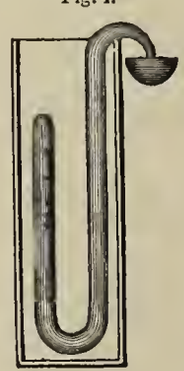
We then experimented with a new No. 1 eudiometer, by moistening the interior short sealed end thereof with water, and supplying it with linseed oil instead of the mercury used in our first experiment.

This eudiometer was very gradually heated along with a thermometer within a bath of linseed oil to 400°, during which operation the superfluous water and steam was observed to evaporate. Soon after the instrument was heated above 212°, the apparatus, being allowed to cool gradually, showed regular decrements of heat and volumes, corresponding to the behaviour of steam confined under fusible metal.

By only slightly varying the foregoing experiment, an unexpected and immense difference resulted, by merely putting the oil first into a dry eudiometer, and then putting a drop of water into the oil (of full one-tenth inch diameter). On heating the instrument in a bath to 300°, no portion of the water evaporated, nor was any alteration thereof visible at that great heat and little pressure, when the instrument was withdrawn from the bath for inspection. At about 320°, small portions of the drop of water decrepitated like common salt upon hot coals. The crepitations increased in number and in violence with increasing heat, till towards 340° the instrument was withdrawn to preserve it from destruction by the increased violence of the concussions; yet, on looking into the instrument, half the original drop of water still remained unaltered within the oil. This curious experiment first exhibits a combination of water and of heat under perfectly new views. We have here a small body of water, unmixable with oil, and unconfined at the time by little more than atmospheric pressure, (one inch of linseed oil,) prevented from its natural expansion into steam of more tension than four atmospheres, by mere immersion in linseed oil at 300°, and prevented by the same feeble mechanical means from total decrepitation, when sufficiently heated to form, in the natural way, steam of more tension than six atmospheres.

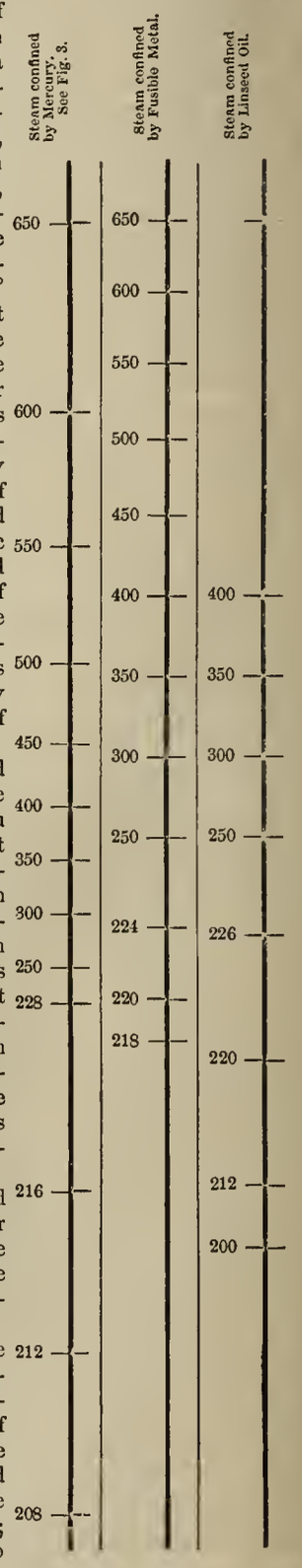
We therefore unquestionably have arrived at a stronger corresponding and corroborative instance of that obscure fact, observed when steam is heated in contact with mercury at temperatures between 238° and 250°, during which the natural expansion of steam seems to be suddenly arrested and wonderfully lessened, which influence acting with decreased effect, seems to vanish at about 500°, and then commences to act with continually increasing effect to the highest temperatures reached in our experiments, 650°.

Fig. 4.



We have collected the results of former experiments into one table, reduced to one scale for easy comparison.

A variation of the foregoing curious experiment will be found below. The accompanying diagram, fig. 4, represents one of several similar glass eudiometers, each one being completely filled with well-boiled water only, as placed within a bath of fusible metal, and gradually heated therein to 650°; thus the water was expelled therefrom into



a cup, till the eudiometer contained only stame, when, the cup being withdrawn, the small open end of the eudiometer was sealed (while hot) with a blowpipe flame, and when the instrument was cooled, the interior thereof constituted an engineer's vacuum, containing only the equivalent or basic water due to the volume of stame the instrument had contained.

Brooklyn, New York. JAMES FROST.

IRON AND GLASS BUILDINGS.

As a reader and admirer of the *Practical Mechanic's Journal*, I should be glad to see in it some examples of iron roofs. For instance, the roof of the Liverpool terminus of the London and North-Western Railway, or the London and South-Western terminus at London Bridge, with its glass covering. I am in hopes one day to see our chapels built of iron columns and glass. Much will be done in this way, when mechanical engineers turn their attention to such structures.

Newcastle, January, 1851. J. K.

[We shall be glad to follow up our correspondent's hint as opportunity may offer. Meanwhile we may refer him to our Plate 16, in Vol. I., for an example of a roof—the Blackburn market-house.—ED. P. M. JOUBNAL.]

SUSPENSION BRIDGES.

I should feel obliged by your giving the formula for determining the strength of chains necessary for a suspension bridge, and also for calculating the strain when the bridge is loaded. I see it stated in some of the papers, that the chains of the suspension bridge now building over the Clyde at Glasgow, are calculated to bear a weight of 2,000 tons, whilst others say 1,600 tons.

I wish some of your correspondents would apply the formula to this particular bridge. What is the cause of the numerous fatal accidents, arising from the giving way of suspension bridges, that have occurred, from time to time, in our own country, and recently in France, when it is invariably stated that they will bear so and so, being at least six times as much as they will ever be required to sustain? What are the dimensions of the various parts of the bridge at Montrose, which broke down soon after it was built, by a crowd of people suddenly rushing to one side?

Glasgow, January, 1851. R. B.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

Nov. 26, 1850.

WILLIAM CUBITT, ESQ., PRESIDENT, IN THE CHAIR.

The discussion on Mr. Struvé's paper, on "The Ventilation of Collieries, theoretically and practically considered," was continued throughout the evening, to the exclnsion of any other subject.

The principal points of the paper were explained to the members who were not present at the reading of the paper. Great stress was laid on the advantages of splitting the current of air, so as to reduce the velocity of its transit through the mine, and to afford a full supply to the most remote points of the workings.

The high temperature in the upcast shaft, necessary to prodnce tbe requisite velocity of current in the galleries of mines when furnaces were employed, was adduced in favour of the employment of Struvé's mine ventilator, or other mechanical means of drawing ont air tbrough shafts which were also nsed for drawing the coal, or raising the men to the surface.

Tbe wasteful application of steam in the form of a jet was insisted on, and contrasted with the small power actnally employed at the Eaglesbush Colliery, for giving motion to Struvé's mine ventilator.

Tbese statements were fully confirmed. It was shown that the speed of the mine ventilator could be regulated to produce any requisite velocity of current in the galleries, and that it was an efficient indicator of the occurrence of any stoppage in the air passages, as, on the supply of air being arrested, the machiue would soon be stopped.

In tbe best mines of the north, furnace ventilation was fonnd to be most efficient, and the stated danger apprehended from the firing of the gas at the furnace was concluded to be more ideal than real. Nevertheless, it was admitted that a good simple mode of mecbanical ventilation merited the best attention of the owners of collieries. Fans for forcing air down into mines had been tried, but were found inefficient, althongh considerable power was consumed in propelling them.

The difficulties found in using mechanical exhausters were then attribnted in a great degree to tbe small size of the inlet and ontlet valves; and the improvements introdnced by Dr. Arnott in the apparatus for ventilating the New County Hospital at York, were instanced as examples of the neccssity for nsing curtain valves, of large area, for the machines, as it had been found, that as the dimensions of the valves were increased, the power required to work tbe machines dimiuished. Tbe most beneficial effects had resulted from the nse of ventilating machines, similar in principle to Struvé's mine ventilator, in hospitals, and on board crowded emigrant and convict ships, and by proper attention to the area of the valves tbe power required to work them was very small. The application of small water-power engines, like those made by Mr. Armstrong of Newcastle, for giving motion to the ventilating machines, was recommended as very effective and most economical.

SOCIETY OF ARTS.

Dec. 11, 1850.

THOMAS MILNER GIBSON, ESQ., VICE-PRESIDENT, IN THE CHAIR.

"On the Different Methods of Bleaching Flax, Cotton, Linen, Calico, and other Fibres and Fabrics," by F. Crace Calvert, F.C.S., Professor of Chemistry in the Royal Institution, Manchester.

Flax was at one period cultivated in warmer climates than at present. It was said that Isis taught the Egyptians to nse it; and it is certain that the cloth which enwraps the mnmmies is made of it.

It is not generally known that there are three distinct varieties of the flax-plant in Belgium, Holland, and France.

1. *Le grand Lin*, from which the finest cambrics are made.
2. *Le Lin chaud*, yielding a large qnantity of seed.
3. *Le Lin moyen*, with a fibre of middling quality.

A knowledge of the existence of these varieties wonld be very nseful to the British flax-grower, whose interest it is to sow that kind which will yield him the seed or fibre most wanted in the market.

In 1849 there were imported, chiefly for sowing, 626,459 quarters of seed.*

Tbe processes employed in preparing the flax for manufactnre are as follow. When fnll grown, it is pulled up and gathered into sheaves or bolls; the seed is then shaken ont, and the straw is steeped in ponds or small streams for three or four weeks, by which fermentation is caused, and acids are generated, which dissolve the gum and resin, uniting the fibre to the stalk. By Schenck's method, water at 90° Fahr. is used, and the steeping is got through in about four days only. The "rated" flax is now exposed on grass for several days, and dried with care; the fibre is then broken away from the stalk, eitber by hand or in the scutching machine, after which it only requires to be hackled, or combed, to be ready for spinning and weaving.

Tbere are two varieties of cotton-tree; the first an herbaceons plant about two feet high, the other a shrub of larger growth. Both have been long known in Egypt, India, and Arabia, and flourish equally well in the United States of America. Cotton was first introduced into Europe by the Venetians in the fourteenth century; but its manufactnre into fabric was reserved for the men of Lancashire. Much encouragement was given by Henry VIII. and Edward VI. to the nascent trade, which at that time was only practised during the intervals of agricultnre. England now imports annnally 6,745,259 cwt. of raw cotton; and besides her home consumption, exports annually 153,166 pieces of calico, and 375,367 pounds of yarn.

To such wonderful perfection have machinery and skill been brought, that Mr. H. Houldsworth is now able to produce 520 hanks of thread to the pound; that is to say, that one pound of cotton-wool, weighing 7,000 grains, is susceptible of giving 520 hanks, each being composed of a thread 840 yards in length; or 7000 grains of cotton-wool can give a thread equal in length to 436,810 yards, or 248 miles.

Tbe fine spinning of flax has also been carried to an extraordinary extent; for one pound of flax fibre is susceptible of being spun with hand-looms into a thread 84,496 yards, or 48 miles in length.

Under the microscope, these two fibres present very different appearances: those of cotton have the appearance of irregular ribbons, twisted on each other, and perfectly transparent in those parts which are not doubled; whilst the flax consists of smooth transparent tubes, intersected at short intervals by joints or knots, similar to those of bamboo or other reeds.

It is useful to know that

100	parts of	linen cloth	dried at 212°	absorb	from 24 to 35	per cent.	of moisture.
100	"	hempen cloth	"	"	26 to 32	"	"
100	"	calico	"	"	23 to 30	"	"

There is an historical fact connected with these two interesting fabrics. It is, that paper made from pith of the papyrus-plant had lasted from 1822 years before the Cbristian era to the eighth century. Egypt was then invaded by the Arabians, and her trade destroyed. It was then for the first time that cotton paper was imported from China by the Arabians, who, two or three centuries afterwards, supplied us tbrough Turkey. The mannfacture of their flax paper was so successful, that cotton paper was completely laid aside until the commencement of the present century, when once more it expelled from the market the linen paper.

The chief operations which cotton undergoes to render it fit for manufacture are:—

1. *The Carding.*—The object of which is to separate the fibres from each other, and take out the seed and impnrities.

2. *The Drawing.*—The object of which is to straighten ont the fibres,—being the analogous process, in this respect, to combing flax, which is inapplicable to cotton,—and also to equalise the substance of the slivers, on which the uniformity of the ultimate yarn depends.

3. *The Roving.*—Tbe object of which is to extend or nnravel the sliver, and

* The importation of hemp has increased from 40,578 tons in 1847, to 53,013 tons in 1849. This is a culture well deserving the attention of our agriculturists.

which entails the necessity of twisting the sliver, or, as it is technically called, the roving, in order to keep the fibres together.

4. *The Spinning.*—In which the roving is extended to its ultimate length, and twisted sufficiently to bind the fibres together, so that they will rather break than admit of extension.

After cotton has been gathered in September, the cotton-wool is separated from the seed and other heterogeneous matters by a machine called a "gin," invented in 1793 by an American named Whitney.

ROYAL SCOTTISH SOCIETY OF ARTS.

The present session was opened on the 11th November, by a valuable address from Mr. Grainger, the president; after which, Mr. Buchanan read an elaborate paper on "The Chimney of the Edinburgh Gas Works." The length of the paper renders it impossible for us to find room for it at present, but we shall return to it next month, giving, meanwhile, a subsidiary paper by M. Taylor, Esq., the engineer of the works, being "a detailed description of the works."

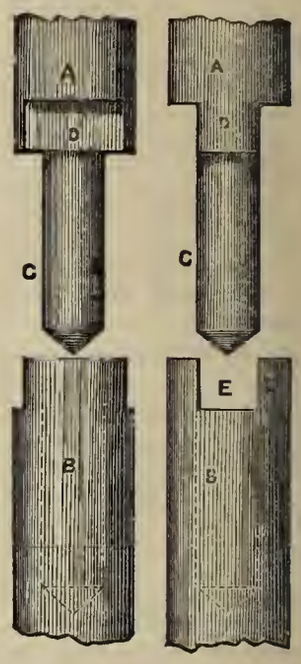
In this paper, Mr. Taylor gave a minute detail of the dimensions and structure of every part of the work. The foundation was on hard shale or clay; the masonry 40 feet 6 inches square at the bottom, 12 feet below the surface of the ground; 32 feet 6 inches at the surface of the ground; and brought up by steps in hard foundation courses of Craigleith stone, dressed and square-jointed. Mason-work of the most substantial description, with four eyes for connecting the main flues to the stalk. Square pedestal 65 feet high from surface of ground to top of base of brick shaft; 30 feet 10 inches square at base course; 30 feet square above base, and 27 feet 9 inches under moulding of top. Body of pedestal of neatly-covered ruble-work of the strongest kind, the stone chiefly from Hailes Quarry of the best rock. The cope mouldings and base of brick; shaft of Craigleith. Within the pedestal, and rising 20 feet above it, is an inner chimney or brick shaft standing quite detached, having a space from 18 inches to 2 feet clear in every part; but this space covered over at the top to keep out soot deposit, but yet left free of the outer pedestal and chimney. The inner chimney is 90 feet high, 13 feet diameter inside, carried up at four different thicknesses, beginning at 3½ bricks thick, and ending at 2 bricks, including a lining of fire-brick, carried up the whole way at two thicknesses—20 feet at 10 inches thick, and 70 feet at 5 inches. The brick-work of the best well-burnt circular stock brick, with a course of headers in reeled order for every four courses of stretchers. The main brick shaft is 264 feet high above the stone pedestal; making, with the pedestal, 65 feet, and foundation 12 feet 6 inches—in all 341 feet 6 inches. The shaft is 26 feet 3 inches diameter at bottom externally, tapers to 13 feet 10 inches at the height of 243 feet, at the first belt under coping 11 feet 10 inches below the top. The shaft is carried up at five different thicknesses, beginning at 35 inches, or 3½ bricks, for 35 feet up, and ending with 15 inches, or 1½ brick, for 58 feet at the top, all built with hard circular composition brick, referred to in the experiments on the strength of bricks. Brick-work put together in the strongest manner with headers, as already described, and best hand all laid in the best lime from Burdiehouse, with sharp sand, sifted and made up in the mill. The beds are kept as thin as possible, and neatly pointed in with the edge of the trowel. All the vertical joints inside of wall, grouted up with thin lime. As a farther security, the shaft is bound with six malleable iron hoops, at intervals of 35 feet up, built into the brick-work, one brick on bed from the outside, and kept ½ inch clear all round off the outside lining of brick-work, so as to allow the hoops to expand with heat without injury to the work. They are all 3 inches broad; the under three 1 inch thick, the upper ¾ inch each, made in three lengths, clamped together and made fast with three ⅞-inch or ¾-inch rivets on each side. The projecting cope at the top is of cast-iron, 19 feet 6 inches diameter over all, and in sixteen pieces about ⅞-inch thick, screwed together with bolts through the flanges. This cope being all fitted and bound together in a mass on the top of the stalk, the brick-work was continued up, and finished with a cope or plate of cast-iron, composed of eight pieces ¾-inch thick, and about 2½ feet broad, with a round belt going 9 inches down on the brick-work, and forming a strong hoop round it. The chimney is furnished with an endless chain going up the inside of the main shaft, giving the means of ascending at any time to the top. The electric conductor stands 6 feet above the top-plate, ⅝-inch round copper made fast to stone and brick-work, with 7⅞-inch copper holdfasts let 4 inches into the masonry or brick-work, with a head on the inside and an eye on the outside to receive the rod as it was carried up. By these holdfasts an ascent can easily be made to the top by a small tackle suspended to the boldfasts. The conductor is metallically connected to all the iron-work on the stalk—the plate on the top, projecting cope, malleable iron hoops, bolts on the top of stone pedestal, and also the ascending chain. The rod descends into a well about 10 feet from the foundation, and is immersed about 8 feet deep in water, and the end turned up 2 feet in a horizontal direction, and flattened.

MONTHLY NOTES.

Scotch Iron.—A meeting was held a few days ago in Glasgow, for the purpose of taking steps to remove the strong existing prejudice against Scotch iron, by practically showing the real status of the iron as compared with that of other districts or countries. The preliminary meeting was attended by members of nearly all the principal houses, connected either directly or remotely with the manufacture, and a committee was formed to consider upon the best means to be adopted in establishing the quality of the Scotch production. This is a most important movement, and we shall look with considerable interest for the details which are intended to be followed out, in effecting what must be so desirable an end, as affecting the interests of the now large community of our northern iron-makers. From what we have heard, we believe the results of experiments already made, will show that Scotch iron does really stand very considerably higher than many other kinds, which, at present, are deemed superior to it.

New Joint for Maclardy and Lewis' Divided Spindle.—In the original construction of Messrs. Maclardy and Lewis' ingenious divided spindles for spinning-frames, introduced a few years back, to allow of "doffing" without removing the flyers, even when top bearings were used, an objection has been taken to the form of joint adopted. The upper portion of the spindle was, in this plan, bored out a short distance, to admit the reduced upper end of the lower length, this end being slotted across to receive a small pin passed transversely through the bored socket. This contrivance, it will be seen, is analogous to that adopted as the usual connection of the flyer to the spindle top, where loose flyers are used. As an improvement, Mr. Lewis has introduced the new form of joint, an example of which we have just had submitted to us, and which is delineated in our engravings. The two views are of the real size. Fig. 1 is an elevation of the joint, with the two ends just clear of each other, and fig. 2 is a corresponding view at right angles to fig. 1. A, Is the end of the upper half of the spindle; B, the corresponding end of the lower half, which is bored out, as represented by the dotted lines, to receive the reduced cylindrical portion, C, of the upper portion. The upper end of the part C, is terminated by a flat portion, D, of the thickness of the part C, and this flat or squared projection fits to the transverse slot, E, on the end of the lower portion, B, of the spindle. The details are so proportioned, that the conical end of the part C, fits to, and rests upon, the corresponding cone in the bottom of the bore in the part B. Thus, when the junction is effected after doffing, the cylindrical end, C, acts as a guide in entering the coupling; and the weight and concussion being entirely borne by this end, the coupling portion, D E, receives no other strain but that necessary to turn the spindle. The joint, it will be seen, is a very cheap one, whilst its efficiency is undoubted.

Fig. 1. Fig. 2.



The Irish Bog Project.—This scheme, which we have previously treated at some length,† appears to have recovered from its lethargy. It is stated that Mr. Reece, by the aid of his newly-discovered powers, for which he has obtained letters patent, effects the separation of the elementary constituents of the peat by a process of combustion, the peculiarity of which consists in its being supported by the oxygen of the air acting on the carbon of the peat, without the assistance of extraneous fuel. During this process a large portion of the hydrogen and other inflammable gases which are evolved, is saved from dissipation, and preserved as sources for the production of heat, to be applied in completing the after stages of chemical manipulation, by which the manufacture of the commercial products is perfected. But beyond the quantities of inflammable matter consumed in these applications, a large amount of gas remains at disposal for the generation of heat in other industrial operations. In these arrangements is found the extreme economy of the process of manufacture, which is thereby endued, to a great extent, with a self-sustaining power.

The chemical elements which are thus derived from peat, or "bog earth," are produced by Mr. Reece's process in a pure, marketable, and highly remunerative form. The chief products which have been obtained are:—

1. Sulphate of Ammonia.—This salt is principally used in the preparation of muriate of ammonia, or sal-ammoniac; in the manufacture of alum, and in producing the other salts of ammonia, such as the sublimed carbonate used by bakers, and the solution of ammonia for the purposes of the anchill-maker, dyer, &c., and it is most extensively employed as a manure; for which purpose it commands a high price and an unlimited market. It has been, hitherto, comparatively difficult of attainment. Vegetable matter, when azote is one of the elements, as the gluten of wheat, yields ammonia; coal soot also contains it; but the decomposition of coal, effected during the production of carburetted hydrogen for the purpose of gas illumination, forms at present the chief source of ammonia, which, by combination with sulphuric acid, is converted into sulphate.

2. Acetate of Lime—Composed of acetic acid and lime, may be formed by dissolving carbonate of lime in the acid; but by Mr. Reece's process it is distilled from the peat. It is a salt extensively used for producing the ferruginous and aluminous liquors used by calico-printers, and it is also the source of acetic acid for various other purposes.

3. Naphtha, or "Wood Spirit."—This important chemical agent is produced from the peat in great quantities. It is yielded in a pure, colourless, limpid state, resembling in its properties spirits of wine, and differing only in its odour; and from its properties of combining in all proportions with alcohol, ether, petroleum, &c., it is largely used by hatters and varnish-makers, in place of spirits of wine, for dissolving the gums and resins used in their respective trades.

4. Paraffine.—Little was known of this valuable vegetable product, till a few

† Page 121, Vol. II.

years since it was determined by several foreign chemists of celebrity to be a "solid carhuret of hydrogen." Dr. Christison obtained it from the petroleum of Rangoon, and called it petrolin, and Dr. Reichenhach discovered its presence in the products of distilled beech tar. In appearance it is a fatty hut rather firm solid; it is wholly inodorous; at 110 degrees of Fahrenheit it melts into an oily liquid, and evaporates without change; it burns with a pure white flame. It is soluble in alcohol, oil of turpentine, naphtha, and the fat oils when heated; and it unites with spermaceti, wax, and most fatty hodies by fusion. It consists of six of carbon and one of hydrogen. These singular properties fit it in a remarkable manner for the manufacture of candles of a high degree of purity, which are found in use to emit no smell, and to give an intense colourless light.

5. Hydro-Carhon Solvent.—This oil, which is of a thin transparent quality, is well adapted for dissolving gum elastic, gutta percha, and various resins, and will in all probability command extensive use in the preparation of a cheap varnish for rendering sailcloths and other textile fabrics impermeable to moisture.

6. Fixed Oil.—This hody, in combination with tallow, will find general use in lubricating machinery, or, mixed with common oils, it will greatly assist the manufacture of a cheap lamp oil.

Novel Mode of Attaching Gutta Percha to Shoe Soles.—In "A Few Words to Journeymen Shoemakers about Gutta Percha," Mr. Thomas Horlock, an Uxbridge shoemaker, has given a graphic explanation of his ideas of "what the new material will do, and what they may do to turn it to their advantage." He takes his fellow-artisans to task pretty severely for their neglect of the advantages of this substitute for leather, and their "hlind prejudice" against the adoption of what is really so important to their interests. Assuming—what there is certainly no room to doubt—that the new application has already seen sufficient service to satisfy the public of the henefits it promises, he hacks his argument hy a short dissertation on the defects of the existing system of affixing soles, and an experienced remedy for the evil. We are now in the rains and snows of winter, when dry feet are not to he despised, so that this little hit of practical experience may usefully occupy a portion of our pages. One day, when pulling off an old gutta percha sole, Mr. Horlock found that the adhesion had heen so perfect, that it was next to impossible to effect a separation. On examination, it appeared that some holes made in removing several nails in the original leather sole, had got filled up with the gutta percha, so as to form a series of holding pins. This at once led to the idea of making holes purposely for the attachment. Fig. 1 represents the simple tool for making the holes. It is nothing more than a flat piece of steel, with three sharp prongs or points, and is easily made out of an old file, as sketched here. The points are driven into the leather sole with a hammer, in a slanting direction; and when one line of holes is made, the tool is reversed for a second line, thus producing a complete dovetail. Figs. 2 and 3 show the appearance of the leather and gutta percha soles when torn asunder. Fig. 2 is a plan of the leather one as pierced with the holes, each row slanting in opposite directions. Fig. 3, again, represents the gutta percha sole, with the points or projecting pins of the material, arising from its penetration into the holes in the leather. Fig. 4 is a view of another perforating tool, having twelve points; it is suited for lighter work. The attaching surfaces are rasped, and the solution laid on in the usual way.

Fig. 1.

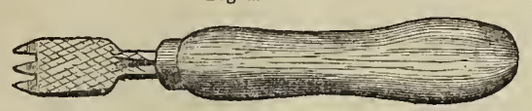


Fig. 2.

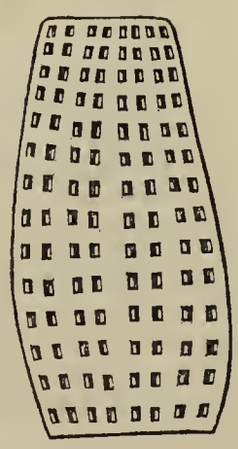
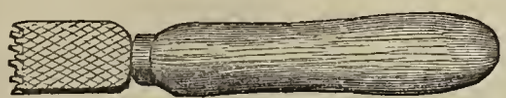


Fig. 3.

Fig. 4.



The Textile Workshops of England.—The total number of factories of all kinds in the United Kingdom, is 4,330; containing 25,638,716 spindles, and 298,916 power-looms. The moving power employed in 108,113 is steam, and 26,104 in water. In the silk-throwing mills, 1,737 boys and 3,916 girls, between 11 and 13, are employed. The total number of children under 13 years of age, employed in factories, who attend school, is 19,400 hoys, and 15,722 girls. The total number of males employed, between 13 and 18, is 67,864; that of females above 13 is 329,577, and that of males above 18 is 157,866. The total number of persons of hoth sexes employed in factories is 596,082.

Science in Naples.—In this country, and in these days, it will scarcely he credited that any government, with even the feeblest pretensions to civilization, should attempt such a strangulation of scientific progress, as is just now heing attempted in Naples. The Neapolitan Government has absolutely prohibited the printing or importation of the works of Sophocles, Lucretius, Lucian, Shakspeare Molicre, Schiller, Sismondi, Lamartine, Thiers, and lastly, Humboldt. What are we to think of the condition of a nation, which, in the fulness of its bigotry and ignorant intolerance, condemns Cosmos?

The "Flax-Cotton" Movement.—In the dearth of parliamentary news, the newspapers have stepped a little out of their usual course in taking up this important suhject. Some time back, Mr. P. Claussen obtained a patent for an improved preparation of flax, whereby this material is said to be made suitable for the great bulk of the nses to which cotton has heen hitherto universally applied. In enlarging upon the vast benefits derivable from such an invention, our contemporaries have overlooked or forgotten, in the midst of their unqualified praise of Mr. Claussen's ingenuity, that an apparently similar process was invented a year or two back hy Mr. Elijah Slack of Renfrew. We give the specification of this very valuable invention in another page; and whilst we thus put our readers in theoretical possession of the process, we can ourselves vouch for the success of its results in practice. Mr. Slack has suhmitted, for our examination, samples of his productions, manufactured, some from flax, some from hemp of the coarsest kind, and some from waste manufactured materials. These samples present a beautifully fine silky appearance, and take any dye in the most perfect manner. We mention Mr. Slack's inventive claims here, for two reasons. In the first place, to advance his well-accredited pretensions to the ownership of the invention; and, in the second, to correct a flagrant error into which the *Morning Chronicle* has fallen in quoting his specification. The paper in question has asserted that, after an examination into the matter, it has decided that Mr. Slack has only laid claim to his peculiar treatment of the textile materials after a previous process of manufacture. This mistake has evidently arisen from great stress being laid upon the fact of the patentee's plan being eminently suitable for working up, into a fine fibre, such coarse and comparatively valueless materials as waste-bags and packing-sheets. In reality, he has, in the first instance, described his invention in its employment of flax and hemp; and he, secondarily, enumerates several waste materials as convertible, by his plan, into valuable textile fibres. More than a year ago, Mr. Slack had his material spun, on cotton machinery, into very fine numbers, and it is now being regularly manufactured by machinery originally designed for cotton. The importance of the suhject deserves our future attention on an extended scale.

ENGLISH PATENTS.

Sealed from 26th December, 1850, to 16th January, 1851.

Richard Rodham, Gateshead, Durham, practical chemist, and Edward Robert Hoblin, Stepney, Middlesex, gentleman,—"Improvements in machinery and apparatus for condensing and purifying smoke, gases, and other noxious vapours arising from fireplaces and furnaces, or from chemical and other works, and in rendering the products resulting from such condensation and purification available for the manufacture of various colours."—December 26th.

Edward Dunn, New York, but now residing in the London Coffee-house, Ludgate-hill, London, master mariner,—"An improved engine for producing motive power by the dilatation or expansion of certain fluids or gases caused by the application of caloric."—26th.

William Hodgson Gratrix, Salford, Lancaster, engineer,—"Certain improvements in the method of producing or manufacturing velvets or other piled fabrics."—26th.

George Edward Dering, Lockleys, Herts, Esq.,—"Improvements in the means of and apparatus for communicating intelligence by electricity."—27th.

John Mathison Fraser, Mark-lane, London, merchant,—"Improvements in the manufacture of sugar."—(Being a communication.)—27th.

John Ransom St. John, New York, America, engineer,—"Improvements in the construction of compasses and apparatus for ascertaining and registering the velocity of ships or vessels through the water."—27th.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman.—"Improvements in the construction of metal shutters,"—(Being a communication.)—27th.

Celeste Menontti, No. 6, Rue de la Paix, Paris, gentleman,—"Certain chemical compositions for reudering cotton, linen, woollen, silk, and other fabrics, impervious to water."—27th.

William Henry Jones, M.A., Queen's College, Oxford, and Chorley, Sussex, clerk,—"Improvements in apparatus to be used when burning candles."—28th.

Thomas Symes Prideaux, Southampton, gentleman,—"Improvements in generating and condensing steam, and in fire-places and furnaces."—28th.

James Slater and John Nuttall Slater, Dunscar, Lancaster, bleachers,—"Certain improvements in machinery or apparatus for the purpose of stretching and opening textile or woven fabrics."—28th.

John Tatham and David Cheetham, Rochdale, Lancaster, machine-makers,—"Certain improvements in steam engines, in apparatus for generating and indicating the pressure of steam, and for filtering water to be applied to boilers; also improvements applicable to steam vessels or ships."—January 2d.

Joshua Horton, Ætna Works, Smethwick, Stafford, steam-engine, boiler, and gasholder manufacturer, trading under the firm or style of "Joshua & William Horton,"—Improvements in the construction of gasholders."—2d.

John Corry, Belfast, Ireland, damask manufacturer,—"Improvements in machinery or apparatus for weaving figured fabrics, which machinery or apparatus is also applicable to other purposes for which Jacquard apparatus is or may be employed."—2d.

Benjamin Cook, Birmingham, manufacturer,—"A certain improvement, or certain improvements, in the manufacture of metallic tubes."—3d.

John Percy, Birmingham, doctor of medicine, and Henry Wiggin, of the same place, manufacturer,—"A new metallic alloy, or new metallic alloys."—3d.

Thomas Lawes, 32 City-road, Middlesex,—"Improvements in generating and applying steam for certain purposes."—4th.

John Harcourt Brown, Fir-cottage, Putney, Surrey, gentleman,—"Certain improvements in the manufacture of wafers."—7th.

Henry Grissell, Regent's Canal Iron Works, Middlesex, engineer, and Theophilus Redwood, Montague-street, in the same county, professor of chemistry,—"Improvements in coating metals with other metals."—11th.

John Alexander Archer, Broadway, Westminster, tobacco manufacturer,—"Improvements in the manufacture of tobacco."—11th.

Samuel Hall, late of Basford, near Nottingham, civil engineer,—"Improvements in the manufacture of starch and gums."—11th.

William Melville, Roe Bank Works, Lochwinnoch, Renfrew, North Britain, calico printer,—"Certain improvements in manufacturing and printing carpets and other fabrics."—11th.

Thomas Allan, Glasgow, Lanark, North Britain, ironfounder,—"Certain improvements in paving or covering roads, streets, and other surfaces of a similar nature."—11th.

George Anstey, Brighton, Sussex, gentleman,—"Certain improvements in consuming smoke, and in regulating the draught in chimneys."—11th.

William Robinson, Holsham, in Holderness, in the East Riding of the county of York, machinist and agricultural implement maker,—"Improved machinery for separating corn from straw."—11th.

John Clarkson Milnes and Samuel Pickstone, Radcliffe Bridge, Lancaster, manufacturer,—"Certain improvements in machinery or apparatus used in spinning, doubling, and weaving cotton, flax, and other fibrous substances."—11th.

Alexander Speid Livingstone, Swansea, Glamorgan, engineer,—"Improvements in the manufacture of fuel."—11th.

Charles Barlow, Chancery-lane, London, Esq.,—"Improvements in propelling."—(Being a communication.)—11th.

Charles Barlow, Chancery-lane, London, Esq.,—"Improvements in machinery for the manufacture of railway chairs."—14th.

Gustav Adolph Buchholz, Agar-street, Strand, Middlesex, civil engineer,—"Improvements in printing, and in the manufacture of printing apparatus, and also in folding and cutting apparatus."—16th.

Robert Cogan, Leicester-square, Middlesex, glass merchant,—"Improvements in the application of plain or ornamental glass alone, or in combination with other suitable materials, to new and useful purposes of construction or manufacture."—16th.

Charles Cowper, Southampton-buildings, Chancery-lane, Middlesex,—"Improvements in the construction of apparatus for manufacturing, and apparatus for retaining and drawing off soda-water and other aerated liquors."—16th.

Frederick Watson, Moss-lane, Hulme, Manchester, gentleman,—"Improvements in sails, rigging, and ships' fittings, and machinery and apparatus employed therein."—16th.

Charles William Lancaster, New Bond-street, Middlesex, gunmaker,—"Improvements in the manufacture of fire-arms and cannons, and of projectiles."—16th.

Jean Marie Taurines, Paris, engineer,—"Certain improvements in the machinery and apparatus for measuring and regulating the working of engines."—16th.

SCOTCH PATENTS.

Sealed from 22d December, 1850, to 22d January, 1851.

Alfred Vincent Newton, Office for Patents, 66 Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in cutting and dressing stone."—(Communication.)—23d December.

Alfred Vincent Newton, Office for Patents, 66 Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in the manufacture of iron hurdles or fences, and of certain other articles in the construction of which ironwork is or may be employed."—(Communication.)—23d.

Thomas Allan, Glasgow, Lanark, North Britain, ironfounder,—"Certain improvements in paving or covering roads, streets, and other surfaces of a similar nature."—23d.

William Hodson Gratix, Salford, Lancaster, engineer,—"Certain improvements in the method of producing or manufacturing velvets, or other piled fabrics."—24th.

James Nasmyth, Patricroft, Lancaster, engineer, and John Barton, Manchester, in the same county, copper roller manufacturer,—"Certain improvements in machinery or apparatus for printing calicoes and other surfaces, and also improvements in the manufacture of copper or other metallic rollers to be employed therein, and in the machinery or apparatus connected with such manufacture."—24th.

Edward d'Orville, and John Partington, Manchester, Lancaster, manufacturers,—"Certain improvements in finishing thread or yarn."—31st.

Thomas Brown, Muscovy-court, Tower-hill, London,—"Improvements in machinery for raising and lowering weights."—31st.

Francis Edward Colegrave, Brighton, Sussex, Esq.,—"Improvements in the valves of steam and other engines, in causing the driving wheels of locomotive engines to bite the rails, and also in supplying water to steam boilers."—31st.

James Forster, Liverpool, merchant,—"Improvements in filtering water."—31st.

James Hill, Stalyhridge, Chester, cotton spinner,—"Machines for preparing cotton, wool, and other fibrous substances, for spinning and doubling."—3d January.

Henry Bessemer, Baxter House, St. Pancras-road, Middlesex, engineer,—"Certain improvements in apparatus acting by centrifugal force in the manufacture of sugar, and other improvements in the treatment of saccharine matter by such apparatus."—6th.

Lucien Vidie, 14 Rue du Grand Chantier, Paris, in the Republic of France, French advocate,—"Certain improvements in measuring the pressure of air, steam, gas, and other liquids."—8th.

John Coope Haddon, Bloomsbury-square, Middlesex, engineer,—"Improvements in the manufacture of railway carriages and of railway wheels, and also of panels for carriages and other purposes."—9th.

Samuel Hall, Barford, near Nottingham, engineer,—"Improvements in the manufacture of starch and gums, and in furnaces and steam boilers, with safety apparatus to be used in such manufacture, and for other purposes."—10th.

John Corry, Belfast, Ireland, damask manufacturer,—"Improvements in machinery or apparatus for weaving figured fabrics, which machinery or apparatus is also applicable to other purposes for which Jacquard apparatus is or may be employed."—13th.

John Ransom St. John, New York, United States, America, engineer.—"Improvements in the process of, and apparatus for, manufacturing soap."—(Communication.)—15th.

John Clarkson, Milns, and Samuel Pickstone, Radcliffe-bridge, Lancaster, manufacturer,—"Certain improvements in machinery or apparatus used in spinning, doubling, and weaving cotton, flax, and other fibrous substances."—20th.

Joseph Gibbs, Devonshire-street, Middlesex, engineer,—"Improvements in manufacturing paints and cements, and panels or surfaces on which paints and cements are or may be applied, parts of which improvements are applicable to other useful purposes."—20th.

Edward Clarence Shepherd, Parliament-street, Westminster, gentleman,—"Certain improvements in electro-magnetic apparatus, suitable for the production of motive power, of heat, and of light."—(Communication.)—22d.

IRISH PATENTS.

Sealed from 21st December, 1850, to 19th January, 1851.

William Henry Green, Basinghall-street, London, gentleman,—"Improvements in the preparation of peat, and other ligneous and carbonaceous substances, and the conversion of some of the products derived thereby; and also in the application of some of such products to the preservation of substances liable to decomposition and destructive agencies, and which mode is also applicable to other products of a similar nature."—Dec. 21st.

Peter Wood, of the firm of Thomas Bury and Co., dyers, calenderers, and finishers, Adelphi Works, Salford, Lancaster,—"Improvements in figuring and ornamenting woven and textile fabrics, paper, wood, leather, and all kinds of materials, substances, or compositions, and in machinery employed therein."—24th.

Henry Bessemer, Baxter House, St. Pancras-road, Middlesex, engineer,—"Certain improvements in apparatus acting by centrifugal force in the manufacture of sugar, and other improvements in the treatment of saccharine matter by such apparatus."—31st.

Charles William Lancaster, New Bond-street, Middlesex, gunmaker,—"Improvements in the construction of fire-arms, cannon, and projectiles, and in the manufacture of percussion tubes."—January 3d.

Joseph Eccles, Moorgate Fold Mill, Lancaster, cotton-spinner and manufacturer, and James Bradshaw, and William Bradshaw, Blackburn, in the same county, watchmakers,—"Certain improvements in, and applicable to, looms for weaving various descriptions of plain and ornamental textile fabrics."—4th.

George Edward Dering, Lockleys, Herts, Esq.,—"Improvements in the means of, and apparatus for, communicating intelligence by electricity."—4th.

James Thomson, Glasgow, Lanark, civil engineer,—"Improvements in hydraulic machinery, and in steam-engines."—10th.

William Thomas Henley, Clerkenwell, Middlesex, philosophical instrument maker,—"Certain improvements in telegraphic communication, and in apparatus connected therewith, parts of which improvements may be also applied to the moving of other machines and machinery."—18th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 17th December, 1850, to 14th January, 1851.

Dec. 17th,	No. 2587.	George Twigg, Birmingham,—"Slide for dress pin."
18th,	2588.	I. Smith, Uxbridge,—"Feed regulator for mills."
19th,	2589.	Dent, Allcroft, and Co., Wood-street, Cheapside,—"Glove fastener."
20th,	2590.	John Capper and Son, Gracechurch-street,—"Folding hasinette or cradle."
—	2591.	H. A. Holder, Birmingham,—"Tricolour hand signal lamp."
21st,	2592.	Robinson and Co., Mount-street,—Carriage lock or wheel-plate."
—	2593.	G. Bolton, Borough,—"Dress or shawl fastener."
—	2594.	Dobson and Medcalf, Lancaster,—"Coupling for sheet metal rollers."
—	2595.	W. Richards, Birmingham,—"Guard for carving fork."
—	2596.	Cottam and Hallen, Oxford-street,—"Fitting for stables."
—	2597.	G. Bolton, Borough,—"Dress or shawl fastener."
—	2598.	E. Shirwood, Birmingham,—"Show-box for jewellery."
—	2599.	D. S. Brown, Old Kent-road,—"Universal barometer."
26th,	2600.	J. Whitehouse and Son, Birmingham,—"Roller-blind furniture."
27th,	2601.	The Hon. W. E. Fitzmaurice, Prince's Gate, Hyde-park,—"Metallic cloth and towel horse."
28th,	2602.	T. R. Gardner, Glasgow,—"Drainage level."
—	2603.	John Keyse, Cross-street, Newington-butts,—"Apparatus for saving lives from drowning."
30th,	2604.	Capper and Waters, Regent-street,—"Sottanello, or under garment for gentlemen."
—	2605.	John Suderwick, Prince's-street, Leicester-square,—"Stem of a tobacco pipe."
—	2606.	Lewis and Allenhy, Regent-street,—"Stella parasol."
—	2607.	W. Richardson, Romford,—"Spring hat-lining."
—	2608.	G. Marshall, William-street, Regent's-park,—"Portable screw wedge door-guard."
1851.		
Jan. 1st,	2609.	J. T. Hewes, Strand,—"Alterion, or life-boat."
—	2610.	Charles Lamport, Workington,—"Steering apparatus."
—	2611.	W. Middlemore, Birmingham,—"Mounthing rein."
2d,	2612.	George Holcroft, Manchester,—"Steam boiler."
—	2613.	George Holcroft, Manchester,—"Steam boiler."
3d,	2614.	William H. Hopkins, Bix, Oxford,—"Bix-Hill-Side plough."
—	2615.	John Cresswell, Birmingham,—"Door fitting."
—	2616.	Henry Weatherly, Theobald's-road,—"Machine for cleaning currants."
4th,	2617.	Louis Braun, Wood-street, Cheapside,—"Cap."
6th,	2618.	John H. Quincey, Hatton Garden,—"Parts of a coal-box."
—	2619.	Amedée Devy, Grosvenor-street, Bond-street,—"Parts of stays."
7th,	2620.	Gaspar Bauchini, Broadwall, Blackfriars,—"Window-cleaning guard."
—	2621.	Peter Rigby, Liverpool,—"Spirit bottle."
—	2622.	John Cresswell, Birmingham,—"A ventilating mattress or cushion."
-	2623.	John Capper and Son, Gracechurch-street,—"Towelling."
9th,	2624.	Edward Upward, South Molton-street,—"Respirator pipe."
—	2625.	Mary Ann Allison, Nottingham-place, Stepney,—"Detectivo pocket guard."
11th,	2626.	Thomas Starkey, Birmingham,—"Button."
—	2627.	Thomas Fuller, Kingsmead-street, Bath,—"Landau carriage body."
13th,	2628.	Samuel and Frederick Hattersley, Westbrook Works, Bradford,—"Eccentric cane, with joint for woolcombing."
—	2629.	John Mark, Exeter,—"Machine for cutting lasts."
—	2630.	John Paterson, Wood-street,—"Polka collar."
14th,	2631.	Thomas Clunes, Aberdeen,—"Rotatory pump."
—	2632.	Leopold Etting, Prince's-square,—"Ship's scuttle."
—	2633.	George Bodley, Broadway, Westminster,—"Safety and ventilating revolving and sliding window-sash."
—	2634.	George Ellis, Fore-street, City,—"Lady's fur cuff."

TO READERS AND CORRESPONDENTS.

PROVISIONAL REGISTRATION OF DESIGNS.—In our note on this subject, p. 239, *ante*, the words "*Useful*" and "*Ornamental*," are transposed. The fee on *Non-ornamental* or *Useful* deslgns is 10s.—on *Ornamental Designs*, 1s.

G. R., Inverkeithing.—1. Certainly none but the well-educated can hope to rise in the profession. Good grounding and training are essentials. 2. A regular pupilage must have been gone through. 3. We are afraid some influence is necessary.—We are obliged by his polite remarks, and reciprocate his good wishes.

W. M. B.—We have the paper marked for use, so soon as we can afford time and space.

A YOUNG MECHANIC.—The plan of exhausting atmospheric railway tubes by the condensation of steam has been often proposed, and we believe practically tried. Messrs. Nasmyth and May obtained a patent for a plan of the kind in 1844. Various other plans have appeared from time to time; the steam being partly employed to force, and partly to exhaust the air; in some instances, by the use of a flexible diaphragm contained in a steamcase, the steam—forcing the diaphragm to one side—being made to drive out the air at the other, an action of a similar nature taking place during condensation.

J. M. J., Westbury, Wilts.—We are not aware that asbestos cloth is an article of manufacture. The use of the material is very limited. It has been tried as an incombustible wick for lamps.

A SUBSCRIBER.—See our illustrated description of the "Cyclograph, a new instrument for setting ont railway curves," page 169, Vol. II., *Practical Mechanic's Journal*,—also, "Bower on setting out curves with the Theodolite and chain of chords," in the *Transactions of the Institution of Civil Engineers of Ireland*, part 3, Vol. II., 1848. The subject has been much discussed in late years.

NOTES ON HEAT.

Almost every change in the molecular condition of matter (such as the combination of an acid with a metal or an earth, the solution of a salt in water) is accompanied by the evolution or absorption of heat; and the quantity of heat evolved or absorbed bears a definite relation to the amount of chemical action.

Heat is evolved by the mechanical compression or condensation of a body, even when no change in its state of aggregation ensues. Heat, on the other hand, is absorbed by the expansion of a body. A little apparatus for obtaining fire, in use a few years ago, but now superseded, consisted of a hollow metal cylinder, with a piston, which, being suddenly driven down, ignited a piece of German tinder at its bottom by the mere compression of the enclosed air. Liquids, being susceptible of but slight condensation, evolve little heat when compressed. The development of heat by compression may be explained thus: a portion of the latent heat required to keep a body in its normal state of expansion, is no longer required in its condensed state, and therefore becomes sensible; in other words, its specific heat is diminished, in consequence of increase of density.

Professor Smyth's method of cooling heated air, lately described in our pages, is founded upon the fact, that compression and expansion heighten and lower temperature. He first compresses the air whose temperature he desires eventually to diminish, and thereby renders a part of its latent heat sensible. The consequence is, that the temperature of the compressed air is raised to the extent of the quantity of heat converted from a latent into a sensible condition. It is then deprived of this increase of temperature, or, to use Professor Smyth's expression, it is robbed of its acquired heat of compression; that being done, it is allowed to expand to its original volume, in which process it absorbs and renders latent such a quantity of heat as is required for its new state. It will be seen that the air, when it has regained the volume it originally possessed, is cooler than it was by the number of degrees of heat taken from it in its state of compression. A rise of 4° is found to take place for each inch of mercurial pressure. A recent American contrivance for the freezing of water is founded on the same principles. Air is first divested of its latent heat by compression; it is then allowed to expand, and being brought into contact with water during the process, the heat it requires is absorbed from the liquid, which loses so much that it freezes.

Some chemical combinations produce cold, as may be seen in what are termed freezing mixtures. No clear explanation of this phenomenon has yet been given. The greatest possible degree of cold is produced by cooling the ingredients of the freezing mixture in another freezing mixture. The ingredients should be finely pulverised, quickly mixed, and in large quantities. A cheap mixture for producing ice in summer is formed by 3 parts of a mixture of 7 oil of vitriol and 5 water, with 4 parts of Glauber's salts. One part of snow, or pounded ice, mixed with one part of common salt, will send the thermometer from 32° to 0°. By dissolving 1 part of sal-ammoniac in 4 of water, a reduction of 27° of temperature will be obtained.

Heat is found united with matter in two modes, viz., by adhesion to the atoms, and by chemical combination with them. The heat which is attached by adhesion has lost nothing of its elasticity, and therefore transfers itself to other bodies of lower temperature as soon as they are brought near the one to which it adheres. It thus renders its presence apparent, and in this condition is termed *free, uncombined, or sensible heat.*

When solid bodies, by the addition of heat, change their state of aggregation, and assume the liquid and gaseous states, part of the heat combines with them chemically, so that it loses, to a certain extent, its elasticity, and becomes insensible both to the feelings and the thermometer. But when these bodies return to their former state of aggregation, this part of the heat is liberated and rendered sensible. This is *combined or latent heat.*

When a quantity of ice at 32° is mixed with an equal quantity of water at 167°, all the ice melts, and the temperature of the whole mixture is reduced to 32°. It therefore appears that 135° are absorbed from the heated water, and are chemically combined with the ice, in order to render fluid a quantity of ice equal to that of the heated water. Water at 32° being mixed with ice below 32°, the water freezes, and the temperature of the ice rises to 32°. 1 lb. of ice at 103° mixed with 1 lb. of water at 32°, will give 2 lbs. of ice at 32°. In this case, latent heat is set free, and raises the temperature of the ice. It would appear that latent heat, like specific heat, varies nearly in the inverse ratio of the atomic weights of bodies; but here again much uncertainty has attended the results of the experiments. The latent heat of water, *i.e.* the quantity of heat rendered latent on changing from a solid to a liquid, amounts to 142°.6. The latent heat of phosphorus is 13°.5, of sulphur, 22°.5.

The *melting point* (*i. e.* the degree of temperature required to induce a body to change its state of aggregation, as a solid for that of a liquid) is very different in different bodies, but the melting point of each body is constant. As long as any part of the body remains to be fused, any quantity of heat which may be added in excess is rendered latent, so that the temperature does not rise with a further accession of heat until the fusion is entirely complete. On the other hand, when a body which has become liquid by the accession of heat, is exposed to a medium of which the temperature is diminished, the liquid gives up to the medium merely that uncombined portion of heat by which its temperature had been raised above the melting point. If the temperature of the medium falls below that point, the tendency of the heat to diffuse itself becomes more powerful than its affinity for the liquid, and hence the latter, being deserted by the heat, returns to its solid state. The point of solidification and the point of fusion are generally coincident. Some liquids, however, water being one, may be cooled several degrees below the melting point before solidification takes place.

Vaporization.—An affinity for heat exists in all ponderable bodies, and it is by the combination of a ponderable basis with heat that all *elastic fluids or gases* are formed. That affinity differs as to intensity with the natures of bodies. Some have a very strong tendency to assume the gaseous form, and are termed volatile. In the case of what are called the permanent gases, it is extremely difficult to deprive them of their heat, so as to reduce them to the state of a liquid or a solid. Indeed, oxygen and some other gases have hitherto effectually resisted condensation. The heat which is in combination with a gas overcomes the cohesion of its ponderable basis to such an extent, that the particles have a tendency to expand without limit, and are only kept together by external force. This expansive tendency is called *elasticity or tension.*

Since every body in the gaseous form occupies a greater space than in the liquid or solid state, it is an indispensable condition of vaporization that the solid or liquid body should not be confined by an unyielding envelope, but should have space to expand. Moreover, it is essential that the pressure of the atmosphere (which, at the level of the sea, is about equal to the pressure which would be produced by a column of mercury 29.92 inches high, or about 15 lbs. on a square superficial inch), should not exceed the elasticity of the vapour at the given temperature. But, as the elasticity increases with the temperature, there is a certain temperature for each body, at which the elasticity of its vapour overcomes the pressure of the atmosphere. This temperature is the *boiling point* of the body, the point at which it is converted into vapour, when the additional heat required to volatilize it is supplied. The phenomenon of boiling or ebullition is produced by the vapour rising in bubbles from the place where it is formed, through the liquid to the surface. It is evident that, with the increase or diminution of the atmospheric pressure, the boiling point rises or falls; and advantage has been taken of this fact, to learn the height of places above the sea, by ascertaining the temperature

at which water boils at such places. In a vacuum, water boils at 68°, ether at 38°, and alcohol at 49°. Evaporation is the name given to vaporization, when it takes place only from the surface of a body.

The elasticity of vapours is either expressed in atmospheres or in inches (in France in metres), and many elaborate experiments have been made with the view of ascertaining the elasticities of several vapours at different temperatures, the results of which have been embodied in tables.

M. Douny's experiments show that the constancy of the boiling point of water, under ordinary atmospheric pressure, depends upon its containing a considerable quantity of atmospheric air; and that, when water is freed from air as far as is possible, the cohesion of the molecules is so increased that a higher temperature is necessary to overcome it, and the boiling point is raised. M. Douny raised water so freed of air to 275° Fahr., under ordinary atmospheric pressure, without its showing signs of ebullition. If its temperature continues to be raised, it will explode. Ice, placed under oil so as to prevent its obtaining air from the atmosphere, on thawing, will also explode on reaching the boiling point.

Water in which salts are dissolved, requires a much higher temperature to make it boil than under ordinary circumstances.

It has already been stated, that, on the conversion of a liquid into vapour, a quantity of heat is absorbed by the latter, and rendered latent. A consequence, therefore, of vaporization is the production of cold, the intensity of which depends, in a great measure, on the rapidity of the process. Dr. Wollaston's cryophorus is a little instrument by which the production of cold by vaporization may be exemplified. It consists of a tube, having at either end a bulb bent at right angles. Water is introduced into one bulb, and, after having been made to boil, by which its vapour fills the tube and the other bulb, the whole is hermetically sealed. When the empty bulb is placed in a freezing mixture, the vapour it contains will be condensed, and the water in the other bulb will be frozen by reason of the rapid vaporization which will take place. Let a thin glass bulb, holding water, be wrapped round with cotton, then let ether be dropped upon the cotton, and a stream of air thrown upon it from the nozzle of a pair of bellows, the water in the bulb will freeze in a short time. A little mercury poured into a watch glass, and covered with liquid sulphurous acid, will freeze in a few minutes when a similar stream of air is made to play upon it.

When a drop of water is thrown upon a red-hot plate of metal it takes a spheroidal form, and is kept in a state of rapid vibration, without touching the plate. The singular experiment of producing ice in a vessel at a glowing red heat has been frequently exhibited in public. A deep platina capsule is heated to a glowing red. Water and liquid sulphurous acid are poured at the same moment into the vessel. The acid, which boils at the freezing point of water, being rapidly evaporated, produces such a degree of cold, that a piece of ice is instantaneously formed, and can be taken out of the vessel. Mercury may also be frozen in a red-hot platina crucible, by putting into the vessel, first, ether, then solid carbonic acid, and then, when the whole is in a globular state, dipping into it 400 or 500 grains of mercury held in a metal spoon.

It is found that different bodies require different quantities of heat to raise their temperature to the same degree, and that they give off unequal quantities of heat on cooling, through the same number of degrees. Hence it is inferred that all bodies do not contain the same quantity of caloric even when indicating the same thermometrical temperature, and they are therefore said to possess different *capacities* for heat. When the quantity of heat contained in a given *weight* of a body, is compared with the quantity of heat contained in the same weight of another body taken as a standard of comparison (the thermometrical temperatures of the two being equal), we obtain a knowledge of the *specific heat* of the first body. And when a similar comparison is made with reference to the heat contained in similar *volumes* of bodies, we arrive at a knowledge of the *relative heat*. The specific heat multiplied into the specific gravity gives the relative heat. Water is usually taken as the unit of comparison in the first case, and air in the second. Attempts have been made to determine the specific heat of various bodies, but the results of the experiments differ so much that we must be considered as still ignorant of the truth.

A mixture of equal quantities of bodies having different temperatures, but the same capacities for heat, will possess the mean temperature of the ingredients. But when bodies of different temperatures and different capacities for heat are mixed together, the temperature of the mixture is not the mean of the temperature of the individual substances. Equal weight of bodies, equally heated, or equally cooled, but of different capacities for heat, raise or lower the temperature of a given quantity of water, through different numbers of degrees—or melt unequal quantities of ice at 32°.

Two of the methods of ascertaining the specific heat of bodies originate in these facts. Another method consists in ascertaining the different lengths of time required by spheres, of equal size and equally heated, of substances with different capacities for heat, to cool to the same point in the same medium. The instruments constructed for carrying these methods into effect are called Calorimeters.

Specific heat of certain bodies, water being 1.0.—*Where two numbers are given, they are the results obtained by different observers:—*

Air,	0.2500	0.3046
Oxygen,	0.1956	0.2750
Hydrogen,	3.2936	6.1892
Nitrogen,	0.2754	0.3138
Carbonic acid,	0.2124	0.2210
Vapour of water,	0.8470	
Alcohol,	0.644	
Ether,	0.503	0.520
Nitric acid,	0.442	
Sulphuric acid,	0.333	
Mercury,	0.333	
Phosphorus,	0.1887	
Sulphur,	0.2026	
Iodine,	0.0541	
Zinc,	0.0955	
Tin,	0.0562	
Lead,	0.0314	
Iron,	0.1138	
Copper,	0.0951	
Silver,	0.0570	
Gold,	0.0324	
Platinum,	"	

The capacity for heat of any given body, increases with the increase of its temperature. Recent researches seem to establish the following points:—The specific heats of many of the simple bodies vary inversely as their atomic weight, so that an atom of any of them, whether its atom be great or small, has the same capacity for heat, and requires the same quantity of heat to raise its temperature through a given number of degrees, as an atom of any other elementary substance. The simple atoms by which a compound atom is formed, retain, when combined, the same capacity for heat which they possess when separate, and, consequently, the heat capacity of a compound atom is the sum of the heat capacities of the simple atoms composing it.

Heat can be polarized like light, and recent investigations in France seem to prove that polarized heat obeys the same laws as polarized light, in its transmission through Iceland spar, and its reflection from polished metals; that the law of Malus as to the intensity of a ray, completely polarized, being divided between the ordinary and extraordinary images produced in traversing the plates, and Fresnel's formulæ as to the varia-

STEAM CRANE.

NEILSON & Cº

Glasgow.

Fig 1.

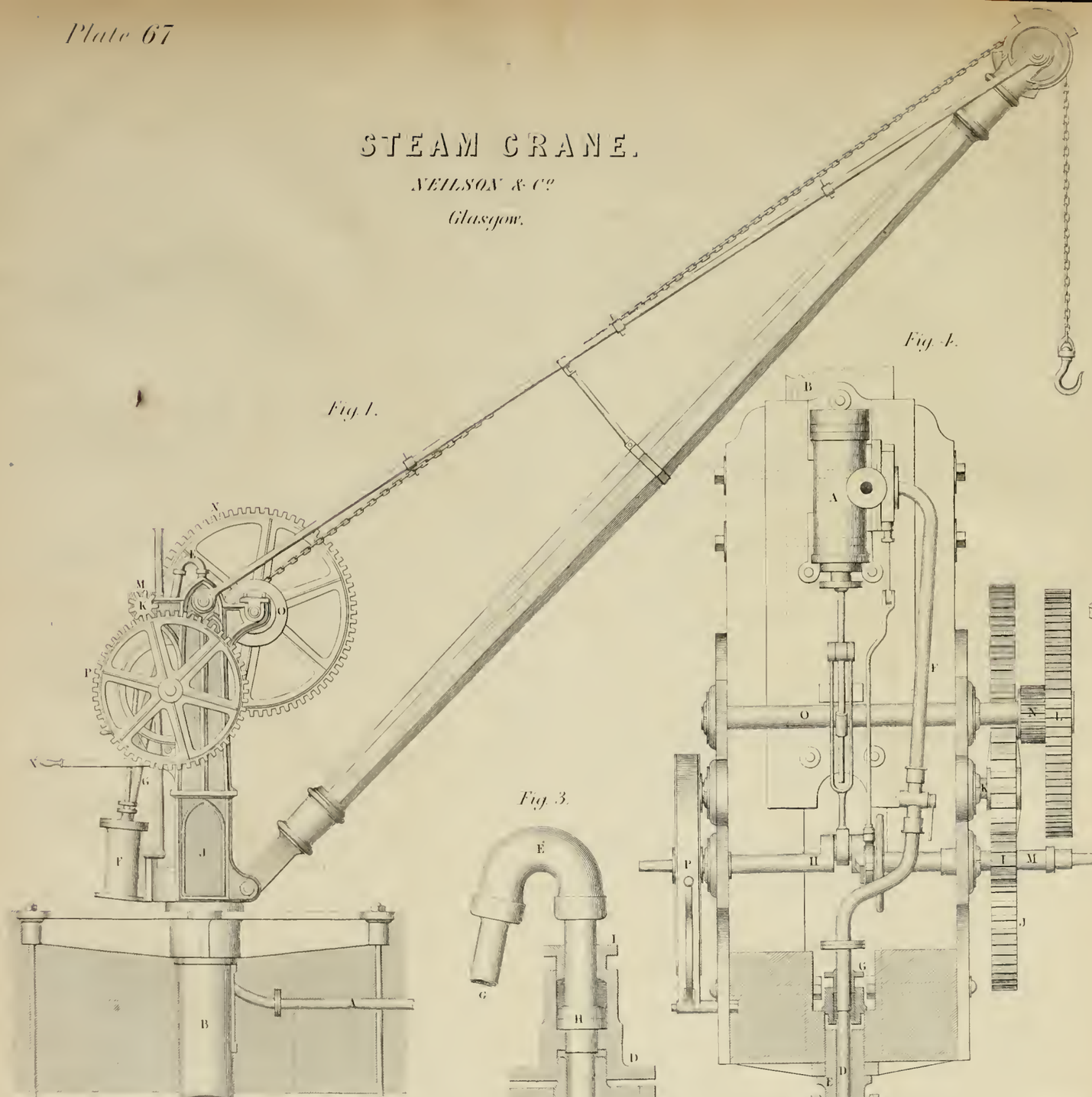


Fig 3.

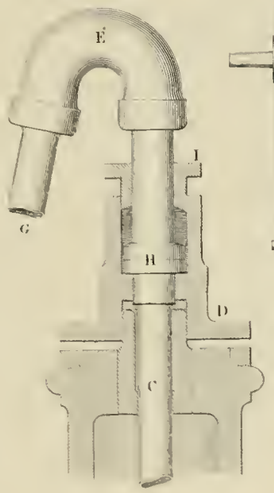


Fig 4.

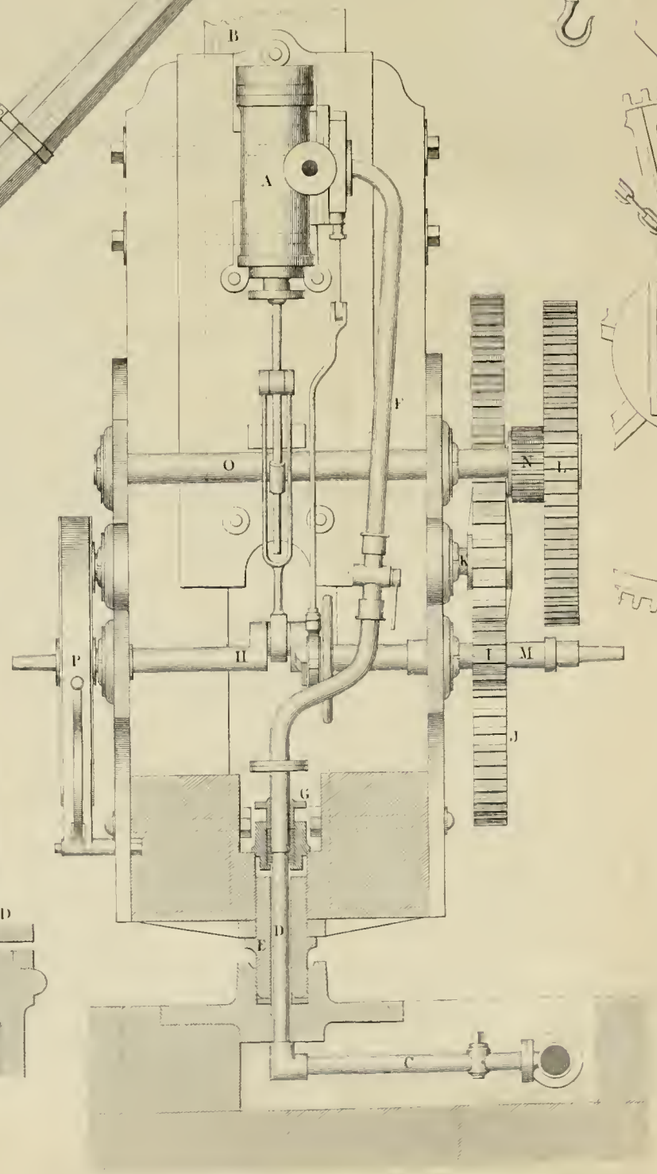


Fig 5.

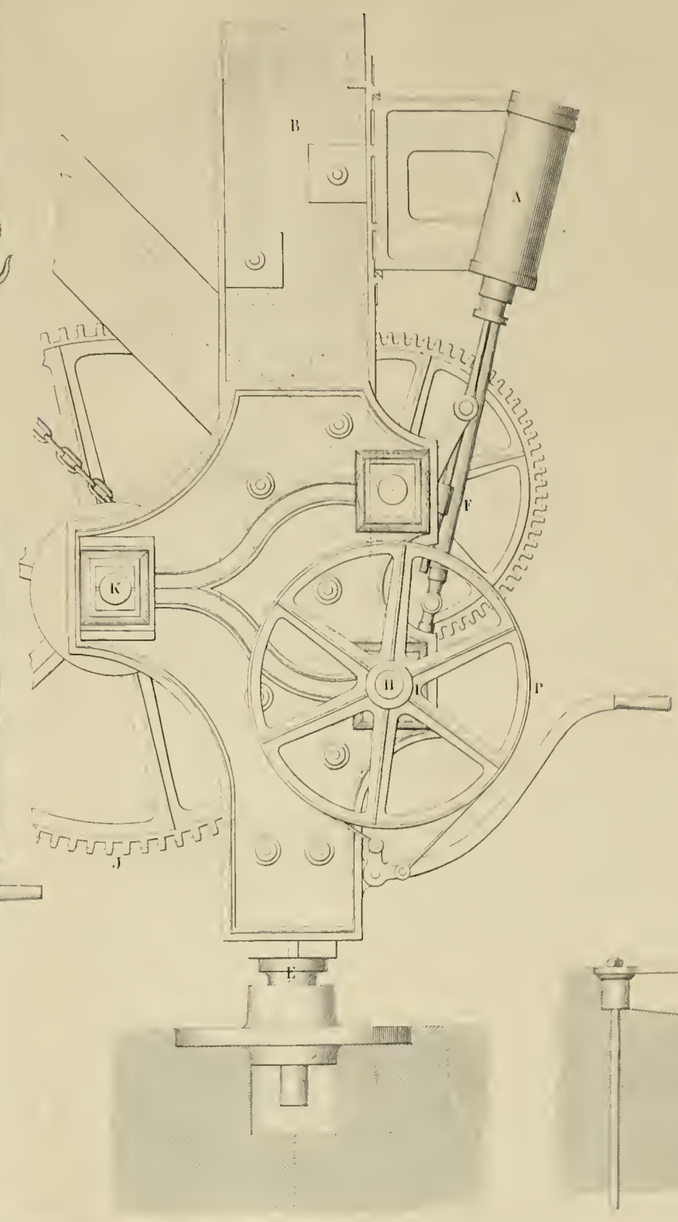
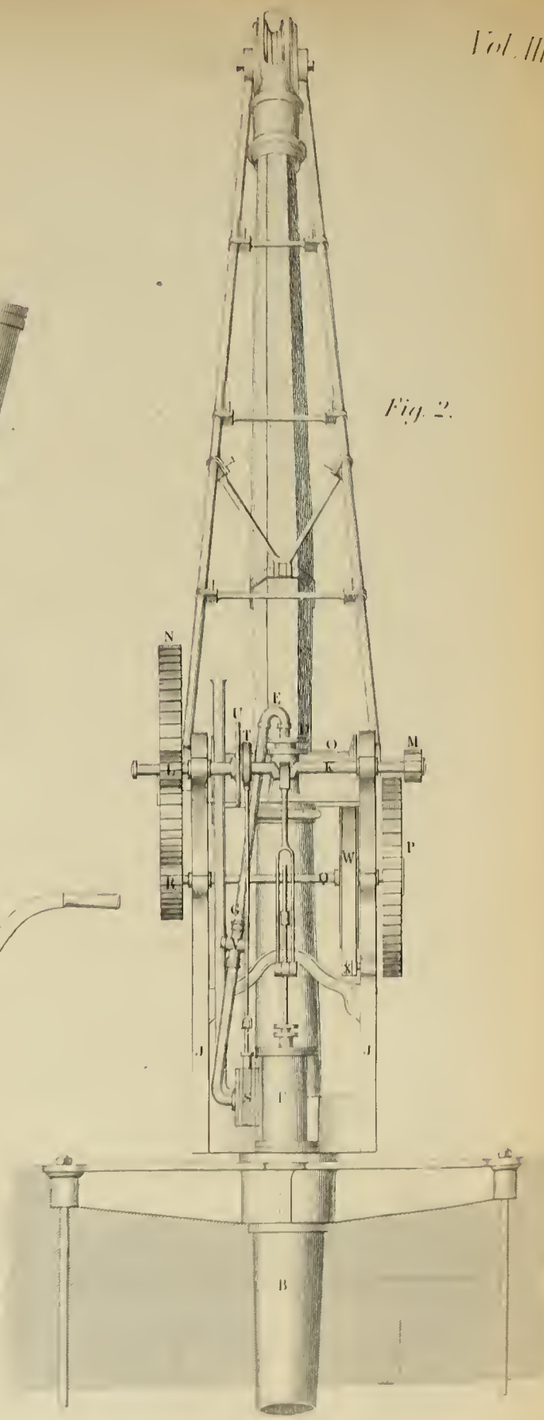


Fig 2.



Scale for Figs 1 & 2

Ins 12 6 0 1 2 3 4 5 10 Feet

Scale for Figs 3 & 5

Ins 12 6 0 1 2 3 4 5 6 Feet

W. Johnson Patent Office
London, Edinburgh & Glasgow

Fig. 5.

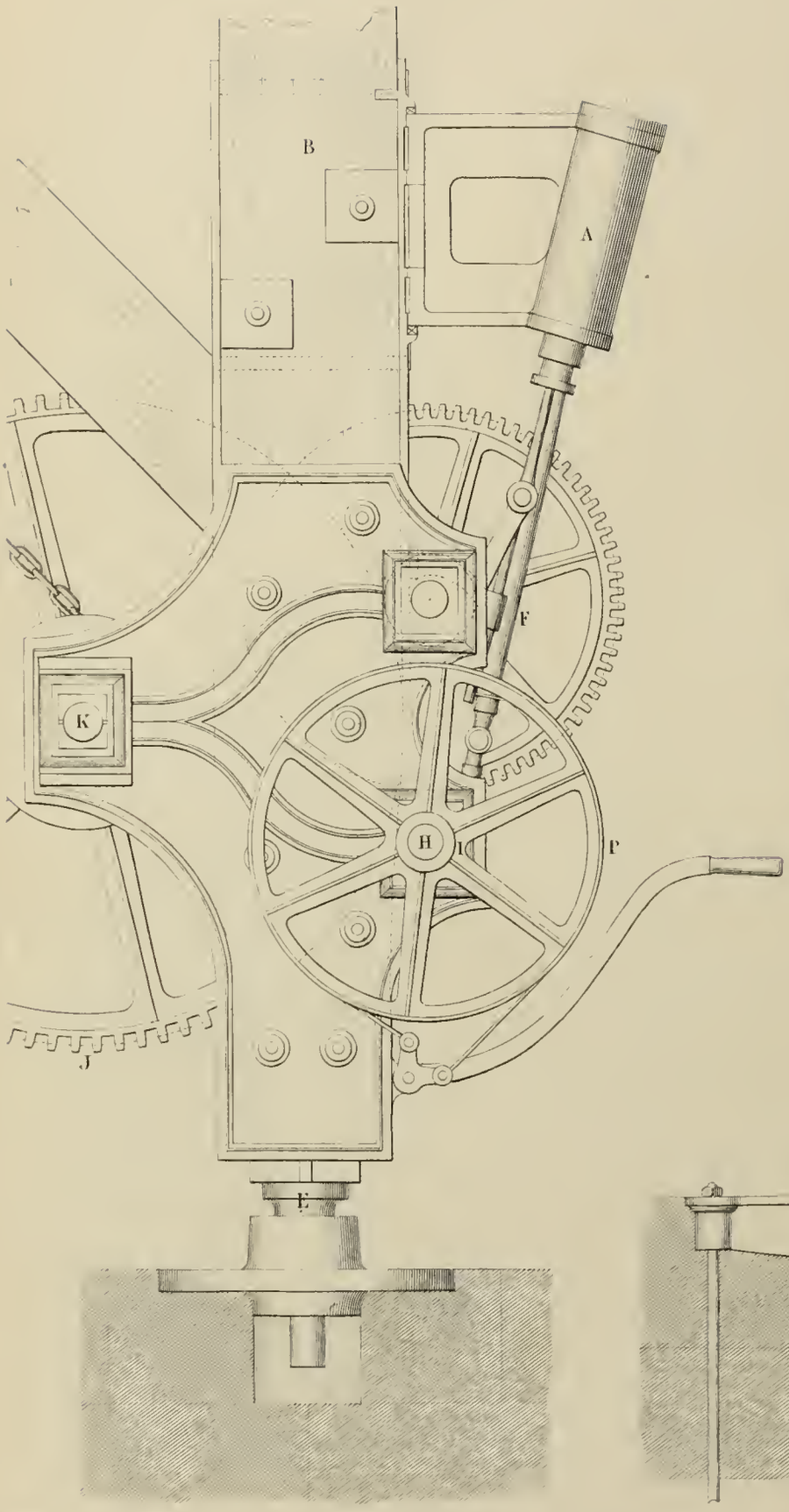
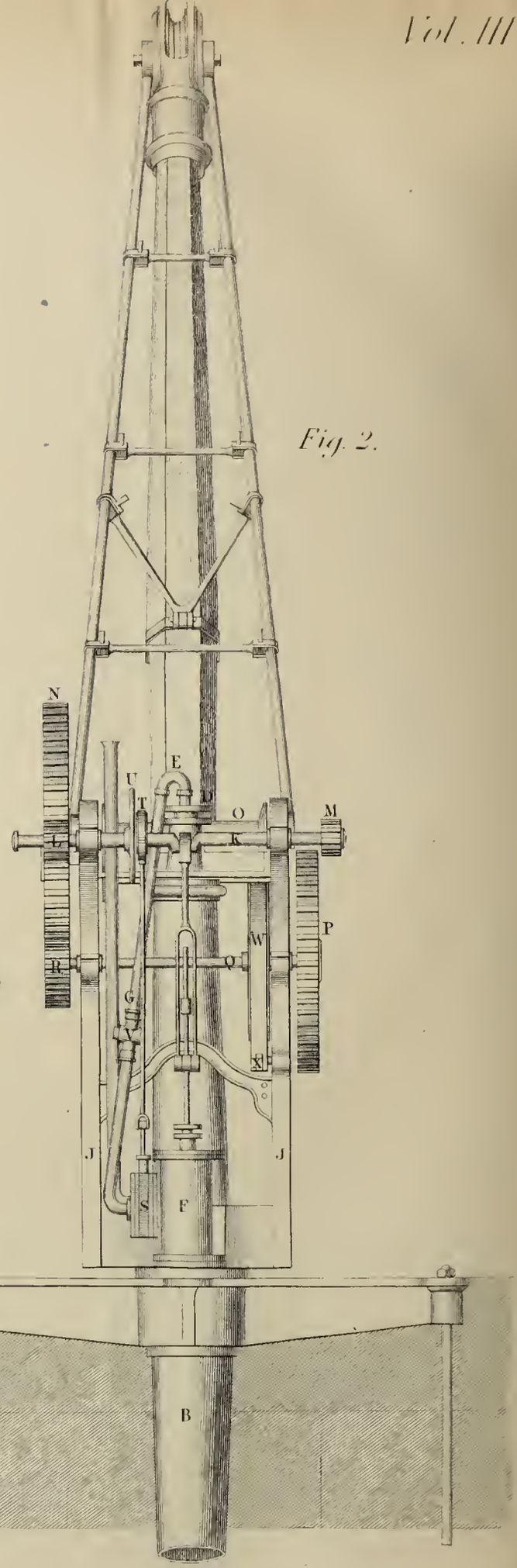


Fig. 2.



Scale for Figs. 1. & 2.

Ins 12 6 0 1 2 3 4 5 10 Feet

Scale for Figs. 4. & 5.

Ins 12 6 0 1 2 3 4 5 6 7 Feet

tions proving the intensity of polarized light, in its reflection from glass under different incidences (the index of heat being taken as nearly 1.5), hold good as to polarized heat.

TEMPERATURE CORRESPONDING WITH THE COLOURS OF INCANDESCENT METAL.—*(Pouillet.)*

Incipient redness, 977° Fahr.; dull red, 1292°; incipient cherry-red, 1472°; bright cherry-red, 1752°; full cherry-red, 1832°; dark orange, 2012°; bright orange, 2192°; white heat, 2372°; strong white heat, 2552°; dazzling white, 2732°.

NEILSON'S STEAM-CRANE.

(Illustrated by Plate 67.)

The names of the Crane, la Grue, der Krauich, la Grua, and la Cigonal, as applied in the English, French, German, Italian, and Spanish languages, to the most important of the machines which we employ for raising and removing heavy bodies, seem to indicate that the long-necked water-fowl has, in each country, been the prototype of these elevators. Indeed, we have another apparent link of connection in the balanced lever, so often met with as an accompaniment to continental wells. A tall fir-tree, weighed at its root end by a stone, is made to rest, by a transverse pin, in the fork of a growing tree, conveniently located by the well's brink, and to the top is attached the rope carrying the water-bucket. The counter-weight is about equal to half the weight to be raised, so that, whilst the bucket must be pulled down to make it reach the water, the dead weight acts effectively in assisting the rise of the bucket when full. The long dipping stretch of the pole in this picturesque elevator, carries us much nearer the original of the bird than the more complex and powerful machine which illustrates our present article.

The lever and axle, the well-accustomed mechanical power of our foresters, is, perhaps, the next advance beyond the poised pole; and the want of a stop-motion in this, no doubt, led to the invention of the "pawl" of the capstan and other machines of the windlass kind. From this point, the varieties of hoisting mechanism branch off into endless applications, dependent on locality and the nature of the work.

Mr. Hague's crane, worked by atmospheric pressure, generated by the exhaustion of an air-pump driven by a steam-engine, was probably the earliest successful result of the substitution of a purely mechanical for a manual power in elevating machinery. A large underground vacuum chest was connected with the air-exhaust pump, and, from this chest, subterranean pipes were led off to each crane, where they were connected with the cylinder of a small engine, turning the pinion shaft. Leakage has ever been a fatal objection to this contrivance, which, for general purposes, has been superseded either by Mr. Armstrong's hydrostatic crane, or by steam-cranes on the plan of Mr. Neilson's.

Our plate exhibits the details of two different arrangements. Fig. 1 is a side elevation of the crane, with a portion of the foundation masonry in section; fig. 2 is a corresponding view at right angles, looking on the back of the crane; and fig. 3 is a detail, showing the mode in which the junction of the steam-pipe with the moving cylinder on the crane-framing is effected.

A, Is the steam-pipe from the boiler. It is laid beneath the floor, and passes by a bend into a slot in the lower end of the fixed crane-post, B. It is here attached to the vertical pipe, C, placed in the hollow of the crane-post, in the line of the centre upon which the crane turns. The upper end of this pipe has a bearing in a bush fitted in the top of the crane-post, immediately over which a cap-piece, D, provides the means for carrying a stuffing-box for the joint of the elbow branch, E, which conveys the steam to the cylinder, F, by the angular pipe, G. This joint allows of the swing of the crane upon its fixed centre, without disturbing the steam-way from the boiler to the cylinder, the junction between the moving pipe, E C, and the fixed one, A C, being managed in a simple and effective manner, by facing the junction ends, H, true. The gland, I, of the stuffing-box, when screwed down, presses the packing down upon the upper collar, and keeps the two faces in contact. The steam cylinder, F, is cast with a bottom bracket, for bolting to the back of one of the side standards or cheeks, J, of the crane. The piston-rod is guided by an eye projecting out from the framing behind, and its forked connecting-rod is jointed directly to the crank on the first motion shaft, K, of the gearing. This shaft carries two sliding pinions, L M, on opposite ends. The pinion, L, is represented in gear with the large spur-wheel, N, on the spindle of the chain-barrel, O, for the quickest hoisting motion. The second pinion, M, is out of gear, but can be slided inwards to gear with the spur-wheel, P, on the shaft, Q, the opposite end of which has a pinion, R, gearing also with the spur-wheel, N, on the chain-barrel spindle. This gives the slow movement for great weights. The slide valve, S, of the steam cylinder is worked by the eccentric, T, on the crank shaft; and close up to the eccentric is a hand-wheel, V, for setting the crank round from its dead centres, when it comes to rest at these points. The regulating cock at V, on the steam-pipe, affords the means of governing the amount of hoisting power to be applied, and the friction strap on the disc, W, carried by the shaft, Q, and worked by the lever handle, X, gives the attendant perfect command, either in stopping the engine at any point in lifting, or in the regulation of the descent of heavy weights. The position of the cylinder at the back of the framing, and in the centre line of the gearing and jib, preserves the whole in balance, without any inconvenient projection. Fig. 4, on plate 53, is an elevation of the lower portion of the gearing and driving apparatus of another arrangement, drawn on a larger scale. Fig. 5 is a corresponding side elevation. The steam cylinder, A, is here inverted, and is cast with a deep bracket for bolting to the back of the crane pillar, B. It is supplied with steam by the underground pipe, C, connected by an elbow union with the vertical pipe, D, in the hollow of the crane centre, E. The upper end of this pipe enters the lower end of the moving pipe, F, passing direct to the slide-valve. The stuffing-box at G keeps the joint steam-tight, and being uncovered and near the foot of the crane, it is easily kept in order. The piston-rod connections are similar to those of the crane already described. The crank shaft, H, carries an adjustable pinion, I, to gear with the spur-wheel, J, on the shaft, K, of the chain-barrel, for the quick movement; and, for the slow one, the same pinion, I, slides outwards to gear with the spur-wheel, L, which is pushed inwards until it is opposite the part, M, of the shaft, H. This movement, at the same time, brings the pinion, N, on the shaft, O, carrying the wheel, L, into gear with the large wheel, J. The regulating friction brake is at P, on the crank shaft.

Nothing can be better fitted for hoisting great weights in docks, harbours, quarries, and especially the heavy castings in foundries, than a crane of this kind. In foundries steam is easily obtainable, and any of the ordinary hands are able to manage the working mechanism.

ON THE PROPULSION OF STEAMERS.*

III.

GROUP V.

Naturalists have long since pointed out the fact, that the power of flight in birds depends on the shape and structure, not on the area, of their expanded wings. These organs have been arranged under six different heads, and in the following order: acuminated, falcate, pointed, rounded, ample, and abortive—a division too minute for popular illustration. Acuminated, *i. e.* long, tapering, and sharply-pointed wings, "are those adapted for the most rapid and long-continued flight." Examples of this form are seen in the oceanic genera, and among land birds the swallow is a familiar example; another is furnished in

Fig. 1. The swallow-tailed hawk. The flight of this elegant species, says Audubon, is singularly beautiful and protracted. It moves through the air with such ease and grace, that it is impossible for any individual who takes the least pleasure in observing the manners of birds, not to be delighted by the sight of it on the wing. Gliding along in easy flappings, it rises in wide circles to an immense height, inclining in various ways its deeply-forked tail, to assist the direction of its course; dives with the rapidity of lightning, and suddenly checking itself, reascends, soars away, and is soon out of sight. At other times a flock of these birds, amounting to fifteen or twenty individuals, is seen hovering around the trees. They dive in rapid succession amongst the branches, glancing along the trunks, seizing in their course the insects and small lizards of which they are in quest. Their motions are astonishingly rapid, and the deep curves which they describe, their sudden doublings and crossings, and the extreme ease with which they seem to cleave the air, excite the admiration of him who views them, while thus employed in searching for food.

Of falcated or sword-shaped wings, humming-birds afford numerous diverse specimens. They have little or no taper, except at or near the tip.

As a specimen of pointed forms, the wings of the chief of feathered races—chief as regards size, strength, and the elevation of its flight—may be quoted. Breeding on the summits of the Cordilleras, inaccessible to man, the condor cruises at altitudes lost in the depths of the firmament to human vision, but whence it watches and darts on its forest prey with the swiftness of lightning. A full-grown bird measures from the point of the beak to the end of the tail only five feet; but from the

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* See P. M. Journal, page 221, *ante*.

tip of one expanded wing to that of the other, nearly *fifteen* feet. The velocity of its flight, and the acuteness of its sight and smell, may be inferred from an observation of Von Tschudi:—"When a bait is laid, it is curious to observe the number of condors that assemble in a quarter of an hour, on a spot near which not one had been previously visible"—arriving from opposite parts of the horizon, and some from distances apparently below it. The largest, and it is presumed the heaviest of birds, dwelling in so rarefied a medium as the Andes, and careering in strata still more attenuated, is a significant fact to the engineer — significant, as showing how the propelling organs of this bird launch out into the medium it moves in — *i. e.* how increased dip, with increased weight, bulk, and velocity, is kept up.

Fig. 2. The argus pheasant, remarkable for a superabundant development of wing, and yet among the poorest of flyers. The body is not larger than that of an ordinary fowl, but its length from the beak to the end of the tail is over five feet, the tail feathers being three feet eight inches. Its general aspect does not strike one as unfavourable to moderate velocity, yet it not only rises with difficulty, but its flight is heavy, and kept up only over short spaces. In this bird we have an example of blunted or rounded wing, united with ample surface, and attended with very imperfect results.

Fig. 3. One of the wrens, birds whose flight is short and slow. Fig. 8. The domestic fowl, is another example of rounded wing, and, as usual, is associated with laborious and indifferent flying. The gallinaceous or rasorial birds are intended to abide principally on the ground — hence their toes are arranged for walking and running, while their organs of flight are less powerfully developed—their wings are short, and, like all short wings, are rounded. Birds of this order, as the Guinea-fowl, turkey, peacock, &c., have all short and blunted wings, and, consequently, are described as possessing, in a very imperfect degree, the faculty of flight.

GROUP V.—AERIAL PROPELLERS.

A specimen of abortive wings is shown at fig. 4. The organ in the ostrich is a large circular blade, which never raises the bird from the ground. The mallard, or wild duck, fig. 5, is a type of the pointed form; few birds so heavy have so small an amount of propelling surface, yet they travel with great velocity, and their migrations extend from the tropics to the polar regions. With slight variations, the wings of parrots, and many smaller birds, resemble these. The passenger pigeon, fig. 9, belongs to the same class; a bird proverbial for its long and rapid progress across the firmament. They have been killed near the city of New York, with their crops full of rice collected in the plantations of Georgia or Carolina; and as this food is digested by them entirely in twelve hours, they must have travelled three or four hundred miles in about half that time — sped through the air at the rate of a mile a minute.

The greatest powers of flying are enjoyed by the different groups belonging to or representing the natatorial order, to which alone those are confined that catch their food in the air — albatrosses, frigate-birds, and petrels, are consequently among the most expert flyers of feathered races. In the fissirostral tribe, we see the same faculty given in a pre-eminent degree to swallows, swifts, night-jars, bee-eaters, &c.

Figs. 10 and 11. Examples of acuminated wings, the most perfect specimens of which are seen in the oceanic genera. Fig. 11 is the tropic bird, celebrated as a remarkably rapid courser; but having a development of rudder unfavourable to quick evolution, its flights are generally direct. Like the frigate-bird, it is found soaring over the remotest parts of the ocean. The wings are described as long, acute; primaries strong, tapering—the first quill longest, and the rest rapidly graduated; the tail of twelve feathers—the two middle ones extremely elongated.

Fig. 12. The frigate pelican, or man-of-war bird, which has been in-

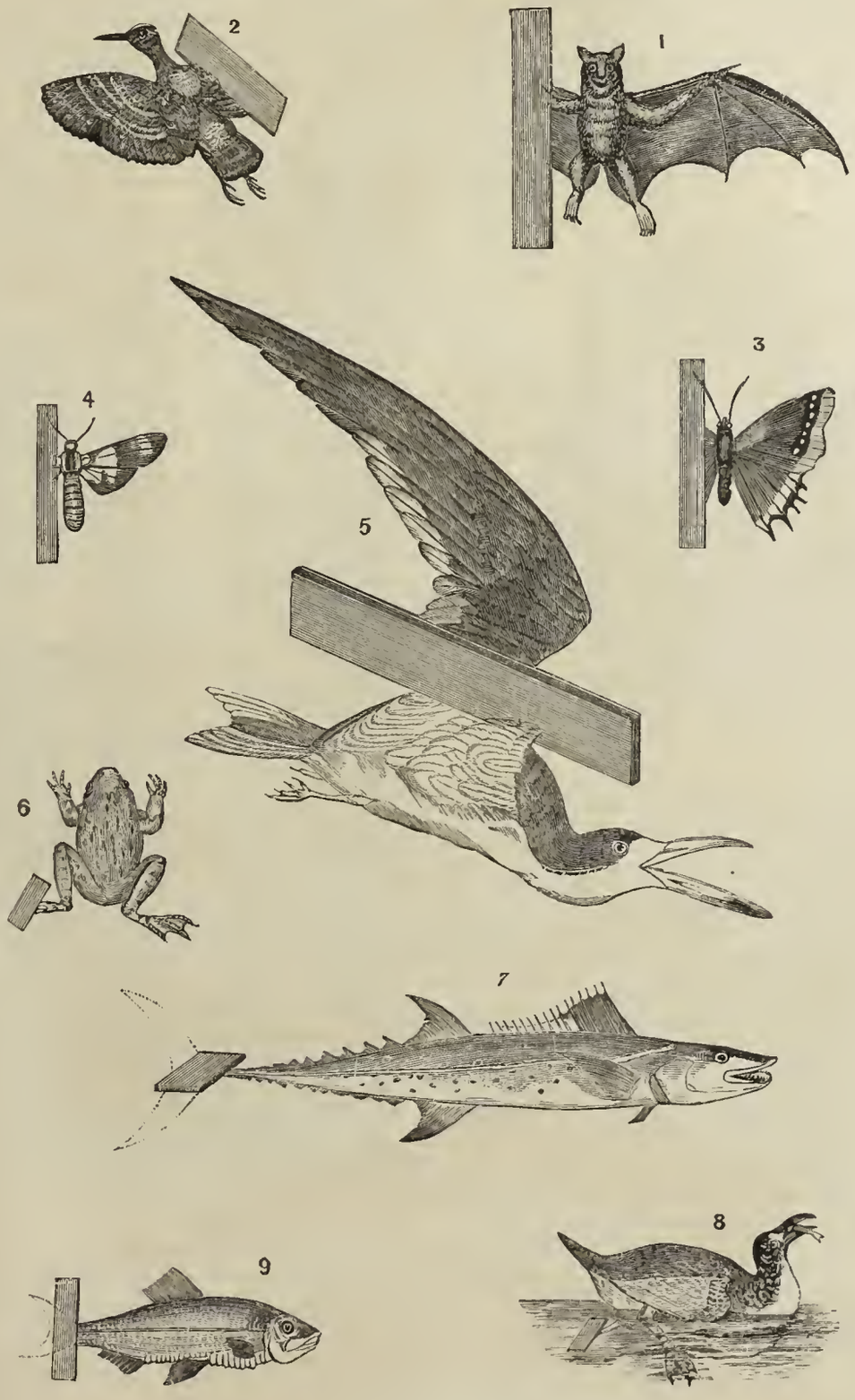
stanced among the most powerful soarers in creation. The figure is from nature—a specimen in the National Collection. The organ is three feet two inches long, and eight inches at the greatest width. The body of the bird, from the point of its bill to the fork of the tail, is twenty-two inches, and to the extremity thirty inches. The speed of this bird is proverbial, and, by means of its double rudder, it changes the direction of its flight with marked celerity—a property the albatross has not, because of its short, broad tail. Hunting within the tropics, such is its power of flight that the air would seem to be its theatre of rest as well as of activity, since it is scarcely ever seen reposing on the water. A pirate by profession, it watches the movements of gulls, tropic birds, boobies, &c., and, soon as they rise, compels them to drop their prey, seizing it as it falls.

Andubon has some interesting memoranda. The wings, he observes, are extremely long and pointed—the first quill longest, the rest rapidly diminishing; the tail very long, deeply forked, of twelve feathers. When incubating, their long wings and tails are seen extending beyond the nests for more than a foot. Those about the Florida Keys are seen passing with the swiftness of thought over trees, and snapping off, as they fly, dry twigs for their nests, with a single grasp of their powerful bills. Only two other birds he knew perform such a feat—the forked-tail hawk, and the swift or chimney swallow—but neither are so expert as the frigate pelican. Sometimes this bird drops a stick while travelling to its nest: when this happens over water, it plunges and recovers it before reaching the waves. Mr. A. thinks this bird possesses a power of flight superior to any other. However swiftly the Cayenne tern, the smaller gulls, or the jager, move on the wing, it is a matter of mere sport for the frigate-bird to overtake any of them. The gos-hawk, penguin, and gyr-falcon—the swiftest of our hawks—are obliged to pursue a green-winged teal, or passenger pigeon, at the highest pitch of their speed, and at times for half a mile, before they secure it; but the frigate-bird comes on it with the velocity of a meteor.

Fig. 13. A wing of the wandering albatross—a bird for endurance of flight probably unrivalled. Found over all parts of the southern ocean, it seldom rests on the water, save in calm weather. During storms, even the most terrific, it is seen, now dashing through the whirling clouds, and now serenely floating, without the least observable motion of its outspread pinions. The figure is from a specimen in the National Gallery, in which the length exceeds 4 feet—the breadth at the widest part being only 8½ inches. The lower edge of the organ is composed of a single row of feathers, forming an outline thin and sharp; while the upper, or front part, is 1¾ inch thick with bone, covered with numerous layers of plumes. At the last joint, towards the tip, the thickness is over an inch—the transverse section resembling that of a razor-blade. The tail is only 10 inches wide at the widest, and 8 inches long from the root.

The two central figs. of the plate, 6 and 7, are the partridge and the black tern; they serve to contrast the rounded with the acuminated form—one of the poorest, with one of the best of flyers. The career of the tern is graceful, light, and extremely rapid. During autumn they hunt for food over the wet prairies, skimming along and picking what they find, without lighting. Between them and the partridge the contrast is as striking as that of the jager and the argus pheasant. The wing of the partridge extends not to the end of the rump, while that of the other is at least double the length of its body.

GROUP VI.—NATURAL, CONTRASTED WITH ARTIFICIAL PROPELLERS.



GROUP VI.

In Group VI. the figures are designed to contrast the contour of *our* paddles and the connection of their broad sides to the levers that work them, with those shaped and joined by the UNERRING ARTIFICER. Some minds are awakened only by extremes of dissimilitude, when a glance often does that which ordinary reasoning fails to accomplish.

Let it not be imagined that anything like caricature is here intended: the purpose is simply to make manifest to the eye the difference between the perfect and imperfect; and *that*, under all circumstances, in philoso-

phical or mechanical disquisitions, is not only justifiable, but useful; at least to those who are more readily convinced through the senses than the intellect alone. Admitting a very wide distinction between a natural and an artificial organ, still, were a parallelogram or a square a legitimate propeller, in the highest or lowest scientific sense of the term, its absurdity, when applied as represented in the plate, could not be so apparent—so repugnant to reason and to ordinary apprehensions,

The laws of propulsion are founded in nature; nothing can change them—nor will they yield a jot or a tittle to our preconceived views and opinions. The idea of extending paddle-blades 20 feet and upwards from a vessel's side—to make them what they are, in fact—"flash wheels,"* skimming up water from the surface, instead of obtaining increased hold by increased depth close by the vessel—is one so unphilosophical, that it probably will not be sanctioned much longer.

From the foregoing, it is most manifest that nature's plan of increasing speed in aqueous organisms, is antipodal to ours—that ideas which prevail with her are wide of those by which our engineers are governed. An additional illustration or two to this point, and the subject is left to those whose interest it is to pursue it.

Fig. 1.

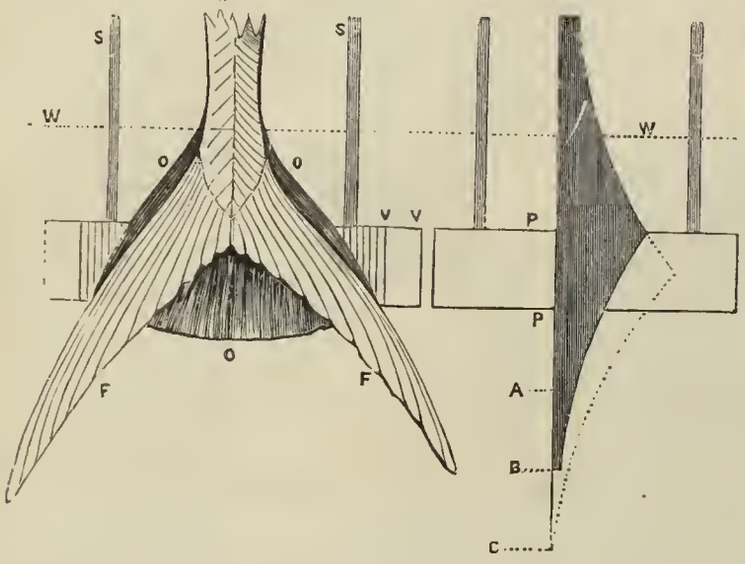


Fig. 2.

Let the dark triangular part of fig. 1, o, o, o, be the caudal paddle of a jaculator, fresh-water bass, or cod—all slow swimmers. Now, the problem is, to make the same amount of propelling surface give double or treble velocity to other fish of equal or even greater bulk—to impart, for example, the speed of the dolphin to a cod. How is this done? Why, invariably, by bifurcating it, and employing the material removed to *extend the lobes*, as at F F. The propelling lever now extends further from the fulcrum, and consequently has not only greater hold on the water, but makes a larger stroke or sweep through it.

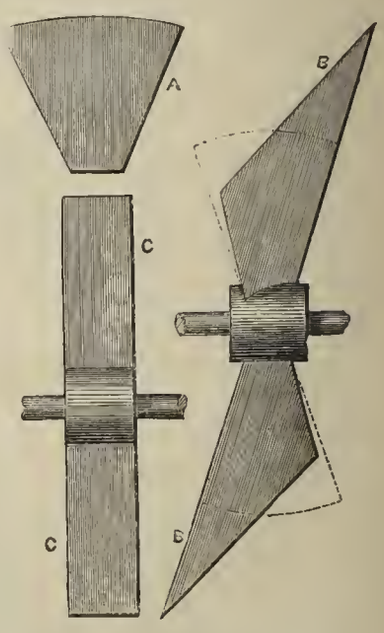
Suppose w w the water line, and the parallelogram, v v, a steamer's blade, attached to the arms, s s. The vessel's speed is required to be increased. How is it attained? Almost always by adding to the surface laterally at v v. Thus, as has been remarked, the ocean steamers now in progress in New York, supposed to embrace every possible improvement, have the paddle planks 14 feet (some boats have them 22 feet!) stretching that distance from each side of the vessels; as if half the surface, disposed after nature's mode, would not be equally efficient, and with the *same power;* for saving of power is as essential a result of improvement in form, as of approaching the truth in any other particular.

Suppose P P, fig. 2, represent one of these enormous blades about to be enlarged to make a vessel go faster, is it not apparent that, by altering its figure to that shown by the dark tint, the rule of nature being followed, superior results must ensue; and this not by adding to, but actually dispensing with about one-half of the propelling surface. Were the boundaries extended to the dotted lines, the area would still be nearly one-third less than the original. In this type of blade, a quality unknown in common ones is revealed, viz., every horizontal section bears a like amount of strain, and contributes equally to the work done, although the areas differ so materially; thus the portion included between the lines A P, from the larger sweep it has to take, equals the larger portion between P P; and for the same reason the section A B equals A P,—*increased range compensating for diminished surface.*† In this, also, we see there is nothing accidental, or without deep meaning, in nature's plans.

The ordinary mode of increasing the efficacy of paddles has been to widen the levers instead of lengthening them. Thus the jar arising from 14 to 20 feet planks striking the water, is a constant source of destruction to both vessel and machinery, while with blades, as figured above, it is annihilated, and the enormous amount of power consumed by it saved.

Some boats have wheel-houses wide as their decks, so as to make it doubtful, in the eyes of strangers to such craft, whether the hulls are accessories to them, or they to the hulls. Who, on beholding a steamer approach, her sharp bows protruding between two enormous drums, is not reminded of a panting animal borne down between two burdens? As has just been remarked, there are vessels whose paddle-blades are 22 feet planks. Adopt the principle here presented, *i. e.* throw away the planks, and with them tons of useless wood and iron—cut off nine-tenths of the portions of the shaft extending over the sides—leave nothing on each end but one set of *arms*, which lengthen and fashion after the caudate lobes of the dolphin or sword-fish; or the wings of the swallow or frigate-bird—and our steamers, no longer allied to awkward and slow-moving organisms, will resemble, in velocity and flight, those from whom the figure and proportions of their motive organs are borrowed.

If nature ever took extra pains to teach engineers a lesson, she has done it here; and let them forget not, that "Nature and Philosophy are *never* at variance."



Devices for readily lengthening and shortening the arms, so as to vary the dip with the changing draught of a vessel, and accurately to adapt it to the power of her engines, are also worth adopting.

The principle is of course equally applicable to stern submerged propellers—revolving sculls or screws. In these the ancient forms are the latest also. Those last patented were proposed over a century ago. A, Is an outline of Woodcroft's, patented here in 1846, and in England previously. Those of Stevens, Loper, Ericson, Smith, and a host of others, have the same sectorial form. Their resemblance to the tails of slow-swimming fish is obvious to every eye. Would it not be better to make each more like the lobe of the most agile and swift, as at B B? A rectangular blade, not unlike one belonging to a paddle-wheel attached to the axis endwise, as at C C, has also been recommended, though on what grounds it is not easy to perceive. The "Great Britain" steam-ship had blades resembling those figured at C C.

* Used for throwing water up slight elevations, for irrigational purposes.

SIMPLIFICATION OF THE MACHINERY OF PROF. P. SMYTH'S "TROPICAL AIR-COOLING APPARATUS."

By William Petrie, Esq., C.E.

The great desideratum for tropical climates—*a continuous supply of cold*, by cheap and simple means—has been shown to be attainable on the principle of the expansion of compressed air; the various parts of mechanism which were described for carrying the principle into practice being such as are familiar in every engineer's workshop.

But in many situations abroad, where the air-cooling apparatus would be most valuable, there is the well-known difficulty of finding a person capable of attending to even the simplest mechanical arrangement without spoiling it, if it be possible to do so—not to mention the difficulty of getting the slightest repairs executed. These considerations render it highly desirable to invent such means as shall accomplish the object *without air-tight moving parts and accurate sliding surfaces*, such as pistons and cylinders, stuffing-boxes, valves, &c.; nay, if possible, *without moving parts at all.* For the cause of the evils to which mechanism is liable consists in the *number* of its moving parts, and the accuracy required in their motions, much more even than in the complication of the fixed form of the parts.

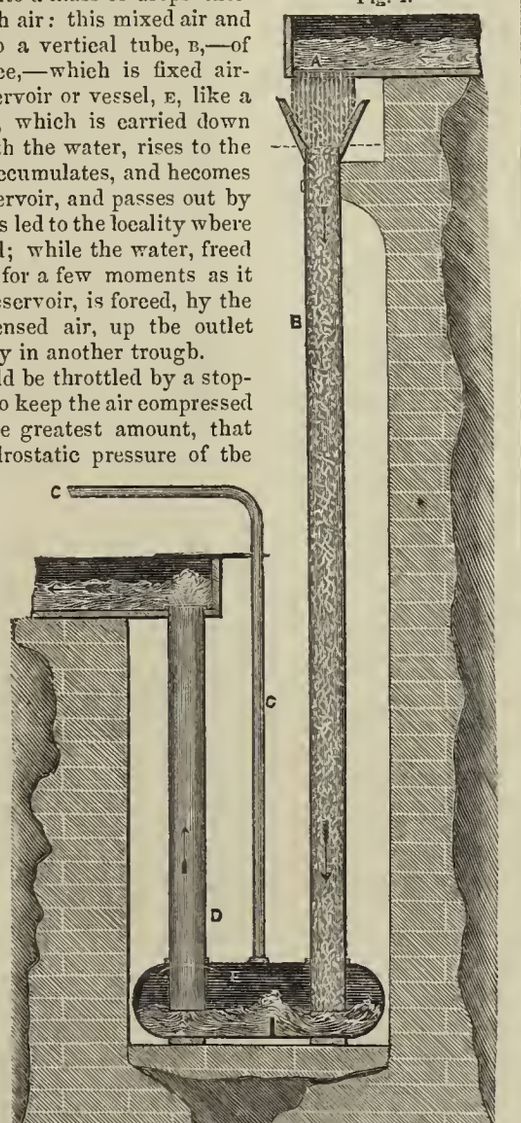
† This is a point which, I believe, no engineer has yet brought out. The idea is a new one in artificial propelling.

The following description shows an apparatus for compressing the air without any moving parts. The principle itself is not mentioned as a novelty, as it has long been successfully employed for another purpose—the supply of air to blast furnaces—in countries where the mechanical arts and sciences are at a very low ebb. And this fact is a practical testimony in favour of our application of the same principle, modified to suit the present purpose. A supply of water, with a fall of six or ten feet, is required in this case, without any other moving power. In the absence of the supply of water, it would be necessary to raise it by mechanical means, if this system were adopted.

Fig. 1 represents the vertical section of the entire apparatus fixed in its place. The stream of water falls through a number of small holes pierced in a metal plate, A, fixed in an opening in the bottom of the trough; the water, after falling for a short distance through this perforated plate, forms into a mass of drops thoroughly intermixed with air: this mixed air and water is received into a vertical tube, B,—of zinc sheet, for instance,—which is fixed air-tight into a small reservoir or vessel, E, like a boiler. Here the air, which is carried down in large quantities with the water, rises to the surface of the water, accumulates, and becomes compressed in the reservoir, and passes out by the air-pipe, C, which is led to the locality where the cold air is required; while the water, freed from air, by settling for a few moments as it passes through the reservoir, is forced, by the pressure of the condensed air, up the outlet tube, D, and flows away in another trough.

HYDRAULIC AIR-COMPRESSER.

Fig. 1.



1-48th.

The air-pipe, C, should be throttled by a stop-cock just so much as to keep the air compressed in the reservoir to the greatest amount, that is, by the whole hydrostatic pressure of the water in the outlet tube, D. If much air is observed to bubble up through D, it is an indication that the air-pipe, C, is too much throttled.

A simple throttled hole in the bottom of the reservoir, E, would let the water off after it had parted with its air, and thus the apparatus may be simplified; but then a large portion of the power would be lost, because the effective fall or length of the descent tube, B, would have to be diminished by the whole height of D, in order to bring the outlet hole in the reservoir up to a level with the off-flow stream.

The water may be mixed with air, or broken into spray, before it enters the descent tube, in many ways besides falling in a shower through the perforated bottom of the trough. And the descent tube may be made of four planks of wood, square; and the air-tight reservoir may be a wooden box, pitched inside, and bound with iron, if such modes of construction were easier to be accomplished.

To obtain the greatest effect from a fall of water used in this way, it is necessary to have the parts correctly proportioned, especially the length of the descent tube, and height of the outlet level above the reservoir, in relation to the specific gravity of the spray in the descent tube, or proportion of air to water in it; the velocity or height of fall with which the spray enters the descent tube, the rate of flow of water, the sectional area of the tube, and the minuteness of the spray as affecting the rate at which the air rises through it—each of these quantities affects the suitability of the rest. Some of the proportions given in the drawing are only assumed as probably the best.

Dimensions.

Flow of water, 120 cubic feet per minute.
Fall of water, from higher level to lower level or outflow, 10 feet.
Consequent power of the stream, 2½ horse power.
The spray in the descent tube intended to be half water and half air.
Diameter, internal, of descent tube (B), 8½ inches.
Total height of descent tube, 16 feet.

Probable best Dimensions.

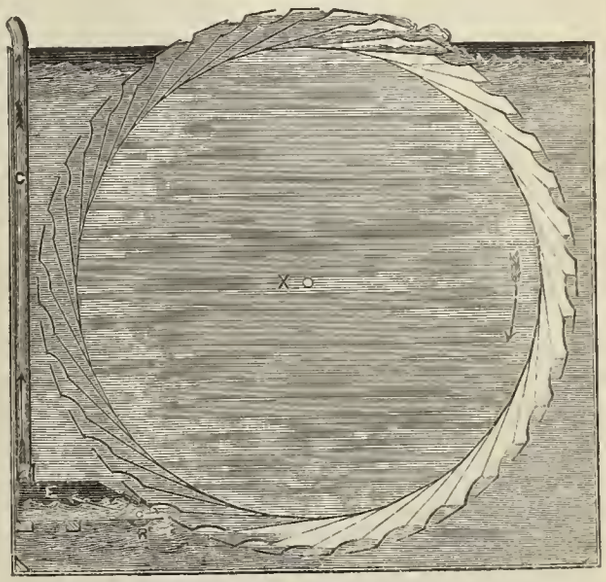
Head of water over the colander (A) at end of upper trough, 7 inches.
Diameter of the holes in the colander, ¼ inch, with a burr projecting on the lower side.
Aggregate area of holes in colander, ½ square foot.
Number of holes, 1,400 or 1,500, arranged, covering a square surface 14 inches in the side, in lines radiating from the centre, to admit air between them from all sides.
Height of fall, from surface of water over the colander, to the *neck* of the descent tube, 2 feet.

Temperature of the atmosphere..... 90° Fah.
Temperature of the water..... 84°
Temperature of air as it rises in bubbles from the water in the reservoir (E) at bottom of the descent tube..... 80°
Temperature of cooled air as it issues from the air-pipe (C), reduced from 90° to..... 54⅔°
Discharge of the cooled air, per minute, 105 cubic feet.

There is one disadvantage in this mode of compressing air, that it will be rather more moist than if it were compressed by a solid piston; but this will be little or no evil in most cases, for the hot air is usually highly charged with moisture in the first instance, and then the cooling of it by expansion, even from a dry cylinder, would complete the saturation of it; it could not, therefore, issue in a *worse* state from the hydraulic compressor; and the drying worm—described in the *Practical Mechanic's Journal* for December, 1850—would remedy this in the one case as well as in the other. But, on the other hand, this hydraulic machine presents some remarkable advantages. There is no need of a cooling apparatus, because, in fact, the compressing apparatus is also a most

AIR-COMPRESSING WHEEL.

Fig. 2.



1-48th.

Dimensions.

From practical level of water at surface, to practical level in *air-receiver*, 8 feet, while the level in the receiver is 1 inch higher than may be allowed before the air escapes from beneath.
Extreme diameter of wheel, 10 feet.
The (uncompressed) air that is discharged (and compressed) into the receiver (and what leaks away) at each revolution of the wheel, is, practically (allowing for a little water adhering in the cells), 0·758333 of the extreme radius (5 feet) square; or, in this particular case, 16·875 square feet, multiplied by the *breadth* of the wheel.
From this we must deduct 0·3 square feet for the divisions of the nests, and 1·434 square feet for leakage at contact of air-receiver with wheel, and air carried in the nests beyond the proper point of discharge, &c. These reduce the section of air to 15·141 square feet.
Temperature of atmosphere, 90° Fahr.
Temperature of ordinary water in flowing, 84°.
Temperature of water in cistern, 85° to 87°—average, 86°.
Supply of water to preserve this temperature, 1½ to 2½ cubic feet per minute, when 105 cubic feet per minute of air is discharged.
Temperature of air just before it is delivered from the lowest nest, 90°.

THEORETICAL LOSSES OF POWER.

The loss by increased floating power of the air as it becomes heated by compression (apart from the contrary effect of *loss* of volume due to compression), is counteracted by the cooling effect of the cell and water by which the air is surrounded, and is, therefore, *nil.*

ADDITIONAL PRACTICAL LOSSES.

Water elevated by the nests as they rise above the surface; each nest contains 1⅛ × as much water as it holds of air when descending, or 1·3 × the bulk that it holds of air at average compression. And this water is discharged at an average height of 6½ inches above the surface. This requires an additional power of 8·8 per cent. of the power that is theoretically requisite to thrust a nest of air 8 feet below the surface, allowing for compression, &c.
Air depressed too low, and bubbling up from average distance of 5 inches, each nest containing 8-10ths of a full charge, or 9-10ths of an average charge of air (for it is compressed)..... 4·6 do.
Loss of air by leakage from reservoir and its parts,..... 8·5 do.
Loss by friction of wheel on its bearings, and by stirring the water by revolving,..... 0·5 do.

Total losses,.....22·4 per cent.

beyond the power theoretically necessary.

perfect cooling apparatus. The loss of coolness—when a piston and cylinder apparatus is used—arising from the residual difference between the temperature of the water which cools, and the air which is cooled, is reduced, in this hydraulic apparatus, to an inappreciable amount, because the air and water are intimately mixed when the maximum of compression is obtained in the lower part of the descent tube, B. The power of the fall of water is applied without the intervention of any mechanism, and yet the mechanical effect will be found probably equal to $\frac{7}{10}$ of the dynamic value of the fall of water. The air is delivered in a steady flow, and without any *taint* of lubricating oil, &c. And there are no moving parts to spoil or wear out, or to be kept oiled or air-tight.

In the case of no stream or fall of water being available, another means of compressing the air will be by *thrusting the air below a sufficient head of water*, say 6 or 8 feet, by means of an *air-wheel*, (fig. 2,) that is, a water-wheel inverted in a tank of water. The mechanical force which would be employed to compress the air by any other means, is here employed to turn the shaft of the wheel, which is immersed to within a certain distance of its highest part; the axis being horizontal, and passing through the tank at one side, or both, with a leather washer, w w, (fig. 4,) to make the hole for the shaft water-proof. This machine effects the compression of the air with but little loss of power—about $18\frac{1}{3}$ per cent. from all causes, more or less according to the shape and size of the air nests; in

AIR-FLOATING WHEEL.

Fig. 3.

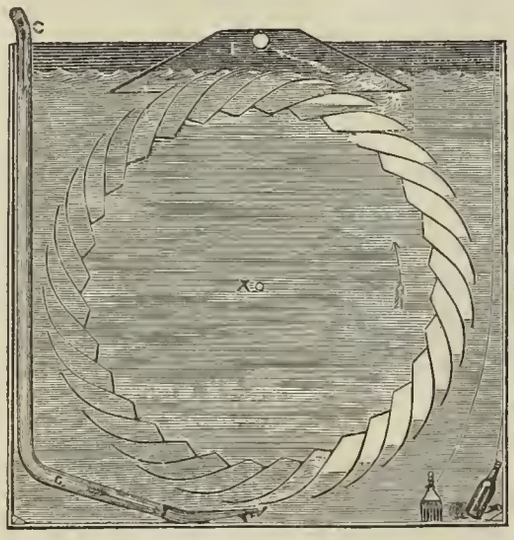
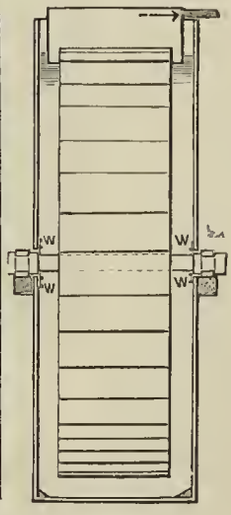


Fig. 4.



1-48th.

DIMENSIONS.

From delivery-nozzle to surface of water,.....8 feet.
Extreme diameter of the wheel,.....8 feet.
The (expanded) air discharged at each revolution of the wheel is equal to a section of air 0·947 of the *extreme radius square*. Or, in this particular case, (radius = 3 feet) 15·16 square feet, multiplied by the breadth of the wheel; from this we must deduct 0·3 square feet for thickness of nest divisions. This reduces the section of air delivered, to 14·86 square feet.
Hence, the breadth of this wheel should be *equal* to that of the air-compressing wheel with which it is to work, (considering the diminution of volume of air by the reduction of temperature, &c.)

Temperature of the air from the pipe of the compresser,.....90°.
Temperature of air on expanding into the receiver, F,.....58⅓°.
Temperature of water in the cistern,.....

THEORETICAL LOSSES OF POWER.

By the *cooling* of the air as it expands, and consequent diminution of expansion..... 4 per cent.

ADDITIONAL PRACTICAL LOSSES.

By bubbling up from below into the nests, through a mean height of $7\frac{5}{6}$ inches from lower circumference, plus 1 inch clearance of air nozzle, $= 8\frac{5}{6} =$ ..... $9\frac{1}{2}$ per cent.

By air escaping from nests before they deliver it at the surface—mean depth of whole escape, $6\frac{3}{4}$ inch = ... 7 do.
Loss by friction of wheel on bearing,..... $\frac{1}{2}$ do.
Loss by stirring the water, by revolving,..... $\frac{1}{2}$ do.

Total losses,.....$20\frac{3}{4}$ per cent.

short, to the first cost of the wheel—provided the forms of the parts be calculated to give a maximum of advantage. These important details are explained to some extent in the drawing, fig. 2; very little water is uselessly elevated by the rising of the nests above the surface, and some of the power so lost is regained by the weight of that portion of the water so raised, which remains in the nests after they have passed to the other side of the line of support. The same may be said of the loss and partial gain by the air in the nests, in passing the lowest point of the wheel. Both of these sources of loss of power might have been lessened by the use of valves in the nests, properly weighted, or by slinging the nests on pins around the wheel; but, as the object in view is to give a machine having few or no moving or detached parts, it is preferred to economise the power by attention to the form of the parts, rather than by introducing additional movements.

The collecting of the air under the receiver, E, as it emerges from the nests, requires some particularity. The edge of the receiver is kept at a uniform and close distance from the edges of the nests, by carrying rollers or little wheels, R, which revolve at each side of the receiver against the edges of the sides of the air-wheel, and are kept pressed against them; and the small horizontal slit or space between the edge of the receiver and periphery of the wheel, is closed by a projecting slip of thick vulcanised caoutchouc-sheet riveted along the edge of the receiver, or along the edge of the nests around the wheel; if along the edge of the receiver, then a similar means of contact is also placed two inches lower, to act when the upper contact is interrupted by one of the open spaces of the nests coming opposite to it. A pipe, C, from the receiver, conveys the compressed air to the locality where the cold air is required. Probably some improved means, different from that here described, may be invented for collecting the air as it emerges from the nests at the lower part of the wheel.

The water in the cistern will gradually become warm by the compression of the air, a small supply of fresh water must therefore be allowed to run into it—entering at the lowest part—while the surplus water keeps running off at the upper part.

The concluding observations respecting the peculiar advantages of the plan, and those on humidity, which are appended to the description of the "Hydraulic Air-compresser," already described, apply in a great measure to this machine also.

Another important object is to devise means for regaining the power lost in the compression of the air, by making the force of its expansion serve to compress the air which follows it; thus not only effecting a saving of the greater part of the force required to work the machine, but also preventing the ultimate re-heating of the cooled air, which, as has been shown, is the effect produced by this expansive force when it is not turned to a useful purpose.

Now it has already been well shown, (*Practical Mechanic's Journal* for October, 1850,) that a piston and cylinder is practically ineligible for gaining the power of expansion from compressed air, when, as in this case, the pressure is small, and the volume large. But it will easily be seen that the *converse* of the air-compressing wheel would be a machine peculiarly fitted for this particular purpose; indeed, the less the compression of the air, the better would the wheel obtain its expansive force from it; for the head of water, and, consequently, the diameter of the wheel, and the weight and cost, &c., would be less.

The proposed apparatus (figs. 3 and 4) consists of a wheel, say 8 feet in diameter, with nests of the same form as those which give the best advantage in an ordinary water-wheel. This wheel revolves on a horizontal shaft, X, in a cistern of water, which covers the wheel to within an inch of its highest part; the shaft passes through one or both sides of the cistern, as described for the air-compressing wheel. The air, compressed by any convenient means, is admitted through a large pipe, C, entering at the top of the cistern, and extending downwards in the water, and terminating in a narrowed orifice furnished with a slight valve, opening outwards beneath the lowest part of the wheel. The air, on issuing from the end of the pipe beneath the wheel, enters the nests, and by its buoyant power causes the wheel to rotate, and is discharged from the nests as they successively come near the surface of the water. The air expands and becomes cool in the nests as they rise from below, and an inverted bell, or box, or receiver, F, fixed over the upper part of the wheel (the edges of the receiver being in the water), receives the cold expanded air, and is conveyed thence by means of a pipe, without any throttling, to the locality where the cold air is required.

The water in this cistern will become considerably cooled by the expansion of the air, and therefore the whole cistern, and parts connected with it, should be well clothed, to keep the heat from getting to it. It will serve as a convenient bath to cool bottles of water or wine in.

The wheel, when properly constructed, with its nests in right form and proportions, as shown in the drawing, will practically yield at least $83\frac{1}{3}$ per cent. of the theoretic expansive power of the air, in the form of rotating power communicated to the shaft, whence the power can be applied to aid in working the air-compressing apparatus, of whatever sort that may be.

But the most desirable arrangement of air-cooling machines, as a

whole, would seem to be the wheel-form of apparatus for compressing the air, in conjunction with the wheel-form for regaining the expansive power of the air. The two would work very harmoniously together, requiring no intervention of wheels and pinions, or other modes of changing the direction, velocity, or inteusity of the power obtained, as must be the case in other arrangements; it would only be necessary to couple the two shafts together, having the cisterns placed within a few feet of one another, and the power gained by the *air-floating* wheel would act at once to aid the revolution of the *air-compressing* wheel, while the extra power required would be applied to the end of one of the shafts, either from steam, wind, or animal power, or (what would be most in keeping with it) *by a second coupling direct to the shaft of an ordinary small water-wheel*, thus again saving gear-work of any kind.

The wheels, both for compressing and floating the air, should have their weight relieved from the bearings of the shafts hy means of the floating power of a hollow drum of wood or sheet-metal fixed in their centres. The nests should be made of thin iron-castings, or of sheet-metal, to spare the space taken up by the thickness of the divisions, and to serve as rapid conductors of heat, to cool the successive charges of air during the few momcnts they remained in the nests.

Proportions and Numerical Data.

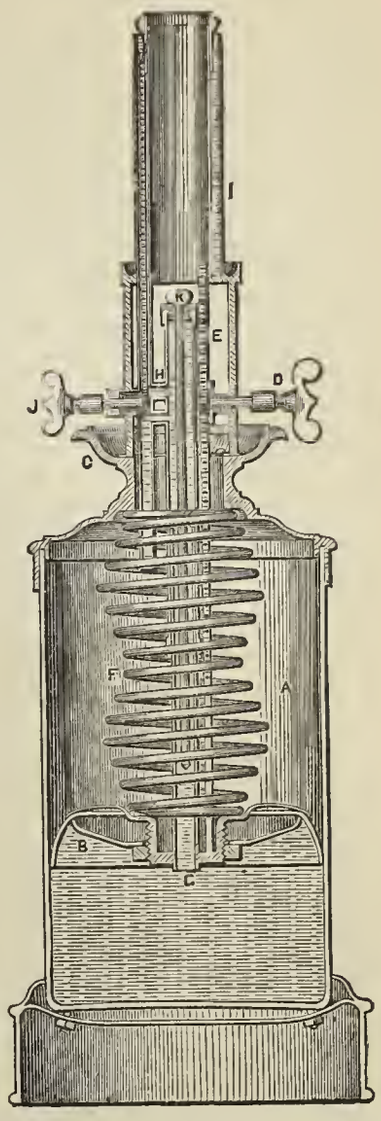
These two wheels, to work well together, should be of the relative sizes indicated in the drawings: namely, 8 feet and 10 feet diameter, or in that proportion; and their breadths *equal*, with the cisterns as small as will conveniently hold them. The level of the water in the two cisterns should be adjusted, so that the air-receiver beneath the water in the air-compressing cistern may be kept as nearly as possible filled with air, with a few bubhles occasionally rising from beneath its sides. It may be stated, as a practical example, that if *temperature* of atmosphere be 90°, and that of natural water 84°; and if the air-compressing wheel be 10 feet in extreme diameter, and 23 iuches in breath inside the nests, shaped as in the drawing; and the air-floating wheel 8 feet diameter, and 23 inches in breadth, the wheels heing made to revolve $3\frac{2}{3}$ turns per minute, they will compress 105 cubic feet per minute of air, and cool it down from 90° to $58\frac{2}{3}$° temp. The power required to work the compressing-wheel at the temperatures which, iu the above case, will practically obtain in the several parts, is, abstractly, 1·42 horse power (1 horse power being 33,000 foot pounds per minute); to which must be added ·318 horse power for practical losses from all causes, making practically a total of 1·738 horse power;—while the power given out by the air-floating wheel at the actual temperatures of its parts, is, abstractly, 1·363 horse power; from which must be deducted ·227 horse power for practical losses from all causes, leaving practically an available net production of 1·136 horse power. This power deducted from the 1·738 horse power to be expended on the compressing-wheel, leaves ·602 horse power to be supplied from some other source of power to work the machine. So that, in fact, the use of the second or air-floating wheel saves nearly two-thirds of the power otherwise required to work the machine, besides affording the two advantages to be mentioned last below. To obtain a greater discharge of air, the *breadth* only of the wheels may be increased, and they may be made to revolve, perhaps, rather quicker.

Thus we have an arrangement at once simple, not soon requiring repairs, and very economical of moving power. The flow of compressed air will always be in precise proportion to the receiving powers of the air-expanding and power-producing apparatus, at whatever rate the machinc be worked. The cool air produced has no taint of oil, &c., and contains no elements of *ultimate re-heating*, as is the case when it jets through a throttled pipe. And there is the advantage of a large bath cf very cold water always at hand, which can serve the purpose of an ice-house.

HADROT'S MODERATOR LAMP.

The reign of gas has not quite brought about the extinguishing of our old principle of portable lights, if we are to take the number and variety of modern oil and candle lamps as anything of a criterion. There are, it appears, still many uses for the oil lamp, and quite enough to stimulate invention for its improvement. In France, where the introduction of gas has been more slowly developed than with us, a great amount of talent has been expended, even in late years, both upon the working mechanism and the ornamental design of lamps. Of these, the *Carcel*, a curious compound of clockwork and pumps, has been very extensively used; but in the search after simplicity, and consequent cheapness of execution, this complicated plan is being gradually superseded hy applications of direct spring pressure. Such a contrivance is "Hadrot's Moderator," which has been submitted to our examination by Messrs. Cronin & Co. of Glasgow.

Our engraving represents a vertical section of the mechanical details of the simplest form of this lamp, as denuded of all ornament. The base of the pedestal contains the oil cylinder, A, entirely closed at the bottom, and fitted with a piston, B, made with a cup-leather packing, somewhat like the packing of a hydrostatic press. The oil is supplied to the cylindrical reservoir in the usual way, by pouring it into the cup, C, whence it runs down into the cylinder on the top of the piston. The piston then being elevated by turning the little handle, D, the spindle of which carries a pinion gearing with a rack, E, fast to the piston; the vacuum beneath the piston causes the oil to pass the sides of the packing, and take up its position beneath, as in the engraving. The elevating power for the oil is obtained from the helical spring, F, formed in four cones, for the purpose of compressing into a small depth. Its upper end abuts against the top of the cylinder, whilst its opposite extremity rests on the piston. When put in action, the piston is wound up to the top of the cylinder, and the downward pressure thus obtained hy the reaction of the spring, forces the oil up the tubular piston-rod, G. The upper open end of the piston-rod, G, enters into the lower open end of a similar fixed tube, fittiug accurately to it, so that the oil, in passing upwards, enters this second tube. Two small side openings at H, conduct it thence to the ordinary annular recess, I, of the wick. The regulator for the height of wick is at J; its spindle carries a pinion, gearing with a vertical rack in the usual manner. It is, however, in the mode adopted for the adjustment of the oil supply to the burner, at all or any state of the spring pressure, that the improvement for which the inventor claims the name "Moderator" consists. The top of the upper tube, over the tubular piston-rod, is closed in by a screw-cap, through which is entered a long spindle, K, of small diameter. This spindle passes directly down the centre of the rod, and whilst it permits of a free flow of oil through the tube, its presence, by producing frictional resistance, tends to retard the flow, or restrict it within certain limits. By this contrivance, the higher the piston is elevated, the further does the fixed regulating rod, K, penetrate into the tubular rod, G; and thus is provided a greater frictional resistance to the flow, just as the greater compression of the spring, F, tends to force the fluid up more strongly.



1-3d.

The "Moderator" appears to answer extremely well in preventing an undue overflow at the burner, whilst its simplicity leaves little chance for derangement.

II.—AN EPITOME OF AMERICAN INVENTION IN 1849.

Saw-Mills.—Some ten patents have been granted this year, belonging to this variety of machinery. Among these is one for sawing wood. The log is placed upon the arms of a revolving feed cylinder, and is raised to the saw. When the sawing of this is completed, another is brought to the saw upon other arms, while the cylinder continues to revolve. Another is for sawing mitres, which is effected by causing circular saws to move towards each other while the board is passing. The motion is governed by guides and regulators, to give the desired angle to the kerfs.

An improvement in barrel saws has also been patented. This saw is made in sections, for greater stiffness; the carriage travels upon adjustable inclined ways, in order to carry the block slightly away from the saw as it receives the cut, and a guide travels with the stave as it is cut, within the saw, for the purpose of drawing it away from the saw. The object is to avoid contact between the saw and the timber, except at the point where the work is done.

Three patents have been granted for improved machines for curvilinear sawing. One is for a mode of regulating the warp of the kerf, especially for ship timber; the log is to be turned in accordance with the guage as the sawing progresses, and the turning of the saw is effected by levers acting with swivels. Another of these mills provides a revolving adjustable platform, which may be elevated and depressed, in order to keep the parts of the log equally above and below the centre of rotation, as the work progresses, and the log is turned. This, it is alleged, will tend to prevent bending and breaking the saw. Another of these mills has arrangements for turning the saw by force applied to the swivels in connection with the saw, near the part where it operates upon the log. The parts are grooved together in such a manner as to act with uniformity, and prevent strain and twisting of the saw.

Fences and Gates.—Seven or eight patents have been granted in this division of the subject. One of those patented, is a gate for a flood fence. It is made to slide up and down in grooves of posts, and has a float attached at the bottom, of sufficient buoyancy to elevate it as the flood rises, and the weight is sufficient to depress it after the flood has subsided. Another of these gates folds up when opened, after the manner of "lazy tongs," within a compass equal to the width of the slats; in opening and closing, it slides upon ways. Another folds upwards, so that the slats, which, when it is closed, are horizontal, become vertical when open and in juxtaposition with each other. A very simple fence is among the patented, made by winding a wire at points near the tops and bottoms of the palings, around each paling, and carrying the wire on to each in succession, and winding around pins in the posts for support, the palings having shoulders above the lower wire, and below the upper one, to keep them in a vertical position.

Turning.—About twelve patents have been granted for improvements in lathes, turning irregular forms, cutting wooden screws, &c. Two of these are for turning right and left-hand lasts at one operation. Two for improvements in gearing for lathes. Another of these patents is for a machine which turns the toes and heels of the lasts perfectly, and presents a new mode of varying the relative portions of the pattern and the last, or other irregular form turned. In two of the machines mentioned, inverted patterns are used. Two slight improvements have been patented in turning screws on bedstead rails. A machine has been patented for dressing irregular forms, in which the cutters travel lengthwise of the block and patterns, they having an intermediate revolution to adapt them to the motion of the cutters. The foregoing machines for turning, &c., are generally too complicated to justify an attempt to present them in detail, without drawings. However useful they may be, they present very little novelty.

About twelve patents have been granted for boring and mortising machines, most of them of a miscellaneous character; such as boring out bungs for casks, boring spools or bobbins, &c. Two of these patents are for boring hubs, to prepare them for the reception of boxes. Both of these machines present improved modes of holding the cutter, and one of them has an improved apparatus for feeding the cutter forward, to compensate for great resistances. One of these machines is for boring ship timber. The augur is carried forward as the boring proceeds, by a rack and pinion, and whenever it is necessary to clear, an auxiliary pinion is thrown into gear and reverses the motion. The novelty is in the manner of producing the motions; the same motions being previously effected by machinery. Letters patent have been granted for two or three other mortising machines. One of these produces the mortise by an endless chain of cutters.

Fibrous and textile Manufactures and Machinery.—Two or three patents have been granted for improvements in woolpickers, or burring machines. One of these is for an improvement in burring cylinders. The patentee winds narrow strips of sheet metal, at short distances apart, around a cylinder; one edge of these strips being placed in grooves in the surface thereof. Hooks are formed in each alternate ring, and the intermediate rings are left without teeth. This arrangement, it is contended, gives a better opportunity for saving the fibres, and more effectually excludes the burrs and other substances which are to be beaten off while the fibres are held.

A mode or process of constructing burring and other toothed cylinders has been patented. It is as follows:—A thin threaded screw, of the size required for the cylinder, has wound around it a covering of thick paper, or pasteboard. The spaces between the threads would thus form a spiral tube. Through the pasteboard, and into these grooves, teeth are inserted, so that their ends will rest upon the bottoms of the grooves. The screw, it will be perceived, thus guides in inserting the teeth. The screw is then taken out by turning it, the ends of the teeth forming the thread of a female screw. A cylinder is then inserted in the place of the screw, and fused metal is poured in between this cylinder and the pasteboard, and allowed to cool. The pasteboard is then removed, leaving the teeth properly set.

Five or six patents have been granted for hemp-brakes and scutchers. In one of these the hemp passes from the feeding apron to pressing rollers, grooved around their circumference, thence between beaters or knives, both sets of which strike the hemp, and while the hemp is held between the beaters, and also between the grooved rollers, scrapers on both sides come upon it with a compound sliding and crank motion, which causes them to move nearly in a flat eclipse, and thus keeps them long in contact with the hemp between. In another of these machines, the hemp passes first between smooth weighted rollers, then between rollers grooved lengthwise, and thence between beaters, both of which move; the beaters having sets of small rollers, or cleaners, revolving between them, to carry the hemp forward, and prevent it from banging between the beaters.

One of the scutchers patented has a large disc, to the face of which the swords are attached in a position tangential to a large hub, or head; the swords being inclined to the face of the disc in an angle of thirty or forty degrees. A rest, of course, is provided to support the hemp during the operation. The foregoing machines are all said to work admirably.

Four or five cotton gins have been patented this year. One of them has an auxiliary grate placed in a position nearly horizontal behind the common grate, and bent in such a manner that the teeth of the saws pass twice through. Immediately back of the point where the saws pass the second time through the auxiliary grate, there is a revolving brush to remove the dust and impurities which are deposited. In another of these gins the ordinary grate is dispensed with, and a screw roller is substituted, of such form as would be produced by winding wire around a cylinder, the coils touching each other. The saw teeth are such as would be produced by making incisions with the edge of a flat file into the edges of a circular plate, leaving the spaces between untouched. By this machine the bolls are kept moving from one side of the gin towards the other, coming successively in contact with different teeth until the cotton is entirely stripped off, and the seed falls out at the end of the machine.

Six or seven patents have been granted for improvements in carding machines. In one of these, the workers and clearers are driven directly by a band from the shaft of the main cylinder. The other has reference to a mode of stripping the cards. Instead of using the well-known flat top cards, cylinder cards are substituted for them. The cylinders have not the usual motion of top cylinders, but they are intended to be almost stationary for the main cylinder to work against, and to carry off the impurities. Upon these cylinders there is a frame containing one stripper for each, and as they revolve very slowly, they are stripped by the vibrating motion thereof.

Sewing Machines.—Machines of this kind, until within a few years, have attracted but little attention; but as they are coming into use, and are found to answer an excellent purpose, the inventor is ingeniously exercising his skill to improve them. No less than five patents have been granted this year for sewing machines. One of these is a reissue of a patent granted some years ago, and need not be noticed. Two of the others are much alike, differing only in minor particulars. The cloth in each, with its edge properly presented to the needle, is secured to a proper feeding apparatus. The needle is placed perpendicular to the cloth in a frame sliding back and forth for inserting and withdrawing it; the eye is near the point. On the opposite side of the cloth is a twisted hook, which slides endwise in a direction nearly perpendicular to the needle; as the needle passes through, the thread is caught by the hook and drawn sidewise, forming a loop. When the needle again passes through the cloth, it passes through this loop also, and the hook moves forward, releasing the old loop, and seizing the new thread, forms a new loop passing through the old one. This operation combined, produces what is well known as the tambour stitch.

In another of these machines, the thread is carried through the cloth by a bent needle, with the eye near the point. The shape of the needle leaves a space between it and the thread. A shuttle, upon a circular way on the side of the cloth opposite the needle, has in it a bobbin of thread. This shuttle is sharp-pointed and curved to adapt it to the way; and as it moves around, it passes through the opening between the needle and the thread, and the needle is then withdrawn, leaving a loop of its own thread around the thread of the bobbin. This, if continued, will produce a seam. The shuttle is driven by two arms from the centre shaft, with

pins in their ends, taking into perforation one in each end of the shuttle, and whenever one of these pins approaches the thread of the needle it is raised out of the way, and the shuttle is driven by the other.

Six or eight patents have been granted for improvements in machines for making cordage. One of these is for an ingenious but rather complicated apparatus, for regulating the tension of the yarns. It could not be made intelligible in this place. Two of the others are intended for making ropes from cotton. The improvements in the nipper, by which, as the strands pass through them, any impurities which may stick to the sides of the strand are removed and thrown out; and in placing in the forming tube, at the point where the strands meet and commence laying, a block, or plate, having a perforation equal to the size of the rope,—this block being able to move laterally, to accommodate irregularity of strain. The springs which press together the jaws of the nippers have also been improved. In another of these machines, the strands are conducted as near to the laying point as possible; each in a direction tangential to an imaginary core of the rope, as nearly as possible in the direction in which the strand is to be laid.

In the last of these machines, several sets of bobbins are arranged about their respective spindles. The threads pass through perforations in a flanch, firmly connected with this spindle; thence they all pass through a single opening in the top of the spindle. The threads or yarns from the bobbins arranged around each spindle, and form a strand. These strands are guided up to the top of the main shaft, when they pass through their respective openings in said shaft to the nippers. The whole receive a sun and planet motion, producing on all parts the proper twist; and the cord is drawn off in the usual manner. The spindles receive their motions from the interior of a fixed ring, against which pulleys, or wheels, on the bottom of the spindles work; the motion being produced by friction. The upper side of the fixed ring is bevelled, and the lower edges of the spindle pulleys are bevelled also, and these last are susceptible of adjustment towards or from the main shaft. This construction and adjustment enables the operator to adjust the relative speeds of the various parts at pleasure, and secures great steadiness of motion.

A very interesting lapping machine has been patented this year, whose details cannot easily be presented without drawings. It has guides so arranged, that whether the number of laps is greater or less, each at once assumes its appropriate position upon the roller. Two very ingenious machines have been patented for twisting the fringe of shawls. They are totally different from each other, but both seem calculated to perform their duty very perfectly and with great expedition.

Two machines have been patented for making weavers' heddles; the one of wire, and the other of thread. The one draws the wire into the machine, cuts off the proper length, doubles it in the proper manner, while the twist is given to it, which completes the heddle.

The other is a kind of loom, using shuttles. It is quite complicated, as may easily be supposed from the duty it performs, and difficult even to understand with drawings. It seems effectually to perform its work.

Spinning.—Some fifteen or twenty patents have been granted this year, for improvements in machinery for spinning. Two of these are for improvements in the self-action of mules, and self-acting jack spinners, of which it is of course useless to attempt an intelligible description without drawings. Another is for a machine for producing yarn of the same kind as that spun on the mule, retaining the spindles always in the same relative position to the draw-rollers. This is said to be accomplished, and perhaps it may be so, however incredible it may appear. A new mode of gearing drawing-heads has also been patented. An improved flyer has been patented, whose arms in their whole length are thin hollow tubes, made of steel, and said to answer well, and to be a great improvement. An improved apparatus has been patented for spinning rope-yarn, in which the flyer has heavy discs at both ends, and in which the drag is produced, and regulated by a forked bar or spring pressing on a washer, resting on a shoulder upon the spindle, the fork embracing the spindle, and the pressure being adjusted by a set screw, thus producing the necessary drag, by pressing the spindle down evenly into its cup. This arrangement is said to produce a steadiness and efficiency heretofore unknown in this department of spinning.

In some spinning machines, the bobbin rests its weight directly upon the circumference of a wheel. The wheel has such a position as to drive the bobbin when in motion. It has been found, however, that when driven in this manner, the bobbin is by little irregularities frequently thrown up, producing much mischief in a process so delicate as spinning. To prevent this, a collar has been interposed between the bobbin and the wheel which drives it. This collar is held down by a collar over the spindle. By this arrangement, these injurious irregularities are prevented from extending themselves to the bobbin.

Looms.—About thirty patents have been granted this year for improvements in looms for weaving. Seven or eight of which, however, are reissues, and have been previously noticed. Machinery of this kind is generally so complicated as to render futile any attempt to describe them without drawings, or within such limits as would be justifiable in this report.

Some years since, patents were granted for two or more looms, in which the shuttle-boxes were worked by a wheel, with two rows of pins in its disc, through the medium of chains, hooks, weights, &c., which machinery was rather complicated. Within the year, a patent has been granted for a loom, in which the pin-wheel is used for the same purpose, but by very different and simple means. The spear or rod which moves the shuttle-boxes, has a shoe affixed to its lower end, with several inclined planes of different lengths. The pins in the wheels are also of different lengths, and their position is changed at pleasure; certain of the pins only will reach the different inclines. These pins, by working directly against the inclines on the shoe, elevate the boxes. They will of course fall when relieved by their own weight. They may be worked for different patterns by merely changing the pins. This arrangement raises the boxes only the space of one box at a time. A subsequent patentee arranges several rows of pins on the pin-wheel in lines, at once concentric with the wheel and radiating from the centre. He uses a single shoe, and the pins are all of the same length; the lower side of the shoe is an inclined plane. As the wheel revolves, the pins, striking against the incline of the shoe, will raise the shuttle-boxes. By this arrangement, the boxes may be so operated, that the highest and the lowest, or any other two, may be used in succession. This will answer for an ordinary number of boxes; but would probably fail if six or eight shuttle-boxes should be used. Another patent has been granted for a loom, having the pin-wheel with one row of pins of different lengths, which is capable of greater compass. It is, however, much more complicated.

Letters patent have been granted for a loom for weaving pile fabrics, which has an auxiliary lay for the purpose of forcing up the wires before the regular beats. The two lays are so arranged as to operate in concert; the action of the one being governed by the other. In another patented loom for weaving coach lace, the figuring wires are drawn out, and inserted by rollers, acting on them like feed-rollers, and at intervals the motions requisite for carrying the wire forward and returning to withdraw another. On one of these looms there are two whip rolls, to compensate for the irregularity of the take-up in figuring.

In another, the figuring cylinder is placed directly below the harness, which is sustained by rigid frames; points project down from these harness frames to fit perforations in the cylinder. The cylinder may be perforated in such a manner that several figures may be woven from it. At each beat of the lay, the cylinder is turned and raised. That part of the harness will be raised, the points on whose frames do not find perforations in the cylinder. If several figures are formed on the cylinder, they must be two or more intervals apart; and there is an adjustment of the apparatus for turning the cylinder accordingly. In this loom one cylinder may be substituted for another at pleasure.

Ore Separaters.—The simplest of these machines, and one of the action of which report speaks highly, consists merely of a hollow cone of tin or sheet metal, having a spindle attached to and passing through its apex, and upon its inner side a ledge or shelf of sheet metal fastened, in the shape of the thread of a nut or female screw. The cone is placed with its apex downwards, in such a manner that it can be revolved upon the above-mentioned spindle, and the ore and water are thrown into the cavity. If the machine be now shaken a few times these will be intimately mixed, and when a whirling motion is given to it the particles of sand and metal will be thrown by centrifugal force towards the exterior of the cone, but the lighter particles will be near the surface, the heavier ones farther down in the body of the machine.

As a current of water is continually introduced, the former will pass out over the edge of the cone-shaped bowl, and the latter will strike against its sides between the different parts of the before-mentioned ledge, and be screwed down into the bottom of the machines, thence to be removed at will, when a sufficient quantity has been accumulated.

A machine, depending for its action, as this does, upon centrifugal force, and the different specific gravities of the materials to be acted upon, has likewise been patented; it consists of two hollow cones, both revolving, and one within the other; as the particles pass over the edge of the inner cone, they are received into the outer one and washed again; but this machine is wanting in the apparatus for forcing the heavy particles to the bottom, and although, from its double action, it appears calculated to produce a better effect, still it is believed that it will, although efficient, not produce as good results as its more simple competitor.

A modification of the first-described machine has also been patented; it has several of the screw-shaped ledges, arranged as a many-threaded screw, and these are in certain places cut entirely away, thus affording

an opportunity to any light particles that may have been caught in the thread, to rise and pass over the edge of the bowl, instead of being forced down with the metal to the bottom of the same.

Another contrivance has been patented, consisting of three vessels, all open at the top, and placed concentrically, the one within the other. The outside one has a bottom, and is placed with its upper edge below that of the intermediate vessel, the top of which is also lower than that of the inmost vessel or tube. This latter extends nearly to the bottom of the first, which is shaped like an inverted cone, and the intermediate vessel or tube extends downwards to the base of this cone. A current of water is passed down through the inner tube, and flows thence into the cone-shaped bottom and ascends, and thence passes out over the edge of the outer vessel, through the ring-shaped space between it and the intermediate vessel. The ore is introduced between the inmost vessel and the centre one, falls through the still water contained in the former, and is met by the ascending current before described, which carries the light particles away with it, while the heavier ones fall into the apex of the cone-shaped bottom. In another machine—also depending upon difference in specific gravity, and currents of water for its action—a tube, wide-mouthed at one, and closed at the other end, is immersed in a stream of water with its mouth towards the descending current; a number of apertures are made in the upper side of this tube, near its lowest end, with adjutages something in shape like the slats of a Venetian blind, through which the water rises at an angle of 45 degrees with the horizon, slanting in the same direction as the current; these slats extend through the bottom of, and into a semi-cylindrical vessel, lying horizontal, and likewise closed on the down stream end. Upon a platform attached to this end, the materials to be washed are deposited. The current, rising through the slats, strikes this end, stirs up and carries with it a portion of the ore, and is deflected by the end in a reverse current over the upward slanting currents before noticed. The heavy particles fall through the slats into the first-named tube, and the lighter ones are borne off by the deflected upward current. It is evident, that the heavy particles, while falling through the slanting currents, must be continually forced towards the back or down stream and closed end of the machine, and it is thus hardly possible that any metallic particles can escape. The slanting currents, acting in connection with the superior horizontal currents, are the novel features in this machine. Many other contrivances for the same purposes have been patented, and are chiefly modifications of the rockers, shaking or stationary inclined tables, and revolving screens, now in ordinary use for separating metals from the foreign matter that is found deposited with them.

A patent has been granted for an improvement in puddling furnaces, which consists in the application of a species of ash-trap between the fire-grate and the working bottom of the furnaces; the products of combustion are forced to traverse this passage, and a great portion of the ashes, fine coal, &c., mingled with them, are caught there, and prevented from injuring the quality and retarding the process of decarbonization which the iron is undergoing.

An improvement in the shape of the crucibles used in treating the ores of zinc has likewise been patented, and consists in forming the crucible like a wine bottle, with the bottom rising high up into the interior of the same. The fire is built inside of this bottom, and the heated air, gases, &c., after circulating in the same, pass out under the edges of the bottle's bottom, and ascends in flues built along its sides; economy of fuel is the chief object attained.

ON CALCULATING THE USEFUL EFFECT OF STEAM-ENGINES.

I.

I have, on several occasions, in your *Journal*, met with the inquiry, how the power of steam-engines was to be calculated, especially when working expansively? There is only one correct principle of calculation as regards the effects of steam-engines, and that is, in my opinion, to be found in the works of M. de Pambour. His formulæ for double-acting engines are:—

$$(1.)\quad v = \frac{S}{a}\cdot\frac{k}{n+q[(1+\delta)r+p+f]};\quad k = \frac{l'}{l'+c} + \log.\frac{l+c}{l'+c}.$$

$$(2.)\quad arv = \frac{Sk}{(1+\delta)q} - \frac{av}{1+\delta}\left(\frac{n}{q}+p+f\right).$$

$$(3.)\quad S = av\frac{n+q[(1+\delta)r+p+f]}{k};\ \text{where}$$

v = the velocity of the piston, in feet, per minute.
S = the quantity of water effectively evaporated per minute, in cubic feet.
a = the area of the cylinder, in square feet.
$k = \frac{l'}{l'+c} + \text{hyp. log.}\frac{l+c}{l'+c}$; where l' represents that portion of the stroke at which the steam is cut off, c is the clearance of the cylinder, &c., and l the length of the stroke, all in feet.
n = a constant quantity, valued at 0.00004227 for condensing engines, and at 0.0001421 for non-condensing engines.
q = another constant quantity, valued at 0.000000258 for condensing engines, and at 0.00000023 for non-condensing engines, where the steam is generated from fresh water.
r = the load of the engine in lbs. per square foot of the area of the piston.
f = the friction of the engine unloaded.
δ = the augmentation of that friction per unit of the load r.
p = the pressure opposed to the motion of the piston, and which, in condensing engines, represents the pressure of condensation in the cylinder, and in non-condensing engines the pressure of the atmosphere.

It is evident that the valves of δ, p, f, and c, may be different in different engines, and that, in order to arrive at an accurate result, they should be respectively ascertained, in each case, by special experiments. For the purpose of a general illustration, however, we may put $\delta = 0.14$; $p = 4 \times 144 = 576$ lbs. for condensing engines, and $= 14.71 \times 144 = 2118$ lbs. for non-condensing engines; $f = 1.5 \times 144 = 216$ lbs. for cylinders up to 17.5 inches diameter, and $= 0.5 \times 144 = 72$ lbs. for cylinders up to 48.5 inches diameter, and $c = 0.05\,l$, or one-twentieth of the stroke.

By applying the above general formulæ we find: from 1, the velocity of the piston for a given evaporation, a given amount of expansion, and a given load; from 2, the useful effect of the engine, in pounds, raised one foot per minute, the velocity, expansion, and evaporation being given; and from 3, the evaporation of the engine for a given load, velocity, and expansion. It will be seen that the formulæ apply equally to engines working without expansion, by merely substituting $\frac{l}{l+c}$ for the term k.

De Pambour's theory of the steam-engine is based upon the facts, that the temperature of the steam acting in the cylinder corresponds at every moment to its pressure, just as it would do if formed at such pressure that instant; that the pressure of the steam in the cylinder varies with the resistance to be overcome by the piston; and that there is necessarily equality between the production and expenditure of steam. Hence it follows, that according to the velocity of the piston and its load, the pressure of the steam in the cylinder may be very different from its pressure in the boiler, although there is one case in which both these pressures may be reduced to an equality, or nearly so.

As the volume of the steam in contact with the water does not change exactly in the inverse ratio of the pressures, De Pambour has, in order to facilitate the calculations, expressed the relative volume of the steam at a given pressure by the formulæ:

$$\frac{1}{n+q\,\mathrm{R}},$$

where n and q are the constant quantities above referred to, and where R signifies the total resistance opposed to the motion of the piston, per unit of surface; consequently,

$$\frac{S}{n+q\,\mathrm{R}}.$$

will be the total volume of steam produced per minute at the pressure R, which volume must be equal to the expenditure, or to

$$av\frac{l}{l'+c}.$$

It is evident that when R = P, (calling P the pressure of the steam in the boiler per square foot,) the case occurs in which the pressure of the steam is nearly the same in the cylinder as in the boiler, and that the value of v is modified accordingly, and corresponds with the maximum useful effect of the engine for a given expansion; which means, that for a given evaporation it is impossible to make the engine perform a higher duty with any other velocity whatsoever. And there is, lastly, the case of the absolute maximum of useful effect to be considered, which is found to occur when

$$\frac{l'}{l} = \frac{\frac{n}{q}+p+f}{\frac{n}{q}+\mathrm{P}};$$

and it is to be understood by this expression, that when the engine works at the velocity corresponding to that amount of expansion, it does the greatest amount of duty which it is possible for it to perform with a given evaporation and pressure of steam in the boiler. Formulæ 1, 2,

and 3, might be modified so as to apply directly to the cases of maximum and absolute maximum of useful effect respectively; but it will be easy to insert, in every instance, the corresponding value of v; and it is only necessary to observe, that in formulæ 1 and 3 we have to substitute $n + q\,\mathrm{P}$ for $n + q\,[(1+\delta)\,r + p + f]$ for the purpose of calculating the cases of maximum and absolute maximum of useful effect. As it might be inconvenient to have to calculate the values of k in every instance, I annex a copy of the table contained in De Pamhour's "Theory of the Steam-Engine," showing those values for every degree of expansion, from $\frac{l'}{l} = 0.10$ to $\frac{l'}{l} = 0.9$

Table for the numerical solution of the formulæ for steam-engines working expansively.

Portion of stroke performed before the expansion or value of the fraction $\frac{l'}{l}$.	Corresponding value of the fraction $\frac{l}{l'+c}$.	Corresponding value of k, or of the expression $\frac{l'}{l'+c} + \log.\frac{l+c}{l'+c}$	Portion of stroke performed before the expansion or value of the fraction $\frac{l'}{l}$.	Corresponding value of the fraction $\frac{l}{l'+c}$.	Corresponding value of k, or of the expression $\frac{l'}{l'+c} + \log.\frac{l+c}{l'+c}$
·10	6·667	2·613	·51	1·786	1·539
·11	6·250	2·569	·52	1·754	1·523
·12	5·882	2·526	·53	1·724	1·507
·13	5·565	2·485	·54	1·695	1·491
·14	5·263	2·446	·55	1·667	1·476
·15	5·000	2·408	·56	1·639	1·461
·16	4·762	2·371	·57	1·613	1.445
·17	4·546	2·336	·58	1·587	1·431
·18	4·348	2·301	·59	1·563	1·417
·19	4·167	2·268	·60	1·539	1·402
·20	4·000	2 235	·61	1·515	1·388
·21	3·846	2·203	·62	1·493	1·374
·22	3·704	2·173	·63	1·471	1·361
·23	3·571	2·142	·64	1·449	1·347
·24	3·448	2·114	·65	1·429	1·334
·25	3·333	2·085	·66	1·409	1·321
·26	3·226	2·059	·67	1·389	1·308
·27	3·125	2·032	·68	1·370	1·295
·28	3·030	2·006	·69	1·351	1·282
·29	2·941	1·980	·70	1·333	1·269
·30	2·857	1·955	·71	1·316	1·257
·31	2·778	1·931	·72	1·299	1·240
·32	2·703	1·908	·73	1·282	1·233
·33	2·632	1·884	·74	1·266	1·221
·34	2·564	1·862	·75	1·250	1·210
·35	2·500	1·840	·76	1·235	1·197
·36	2·439	1·818	·77	1·220	1·186
·37	2·381	1·797	·78	1·205	1·175
·38	2·326	1·776	·79	1·191	1·164
·39	2·273	1·755	·80	1·177	1·152
·40	2·222	1·736	·81	1·163	1·141
·41	2·174	1·716	·82	1·149	1·131
·42	2·128	1·697	·83	1·136	1·119
·43	2·083	1·678	·84	1·123	1·109
·44	2·041	1·660	·85	1·111	1·099
·45	2·000	1·642	·86	1·099	1·088
·46	1·961	1·624	·87	1·087	1·078
·47	1·923	1·606	·88	1·075	1·067
·48	1·877	1·589	·89	1·064	1·057
·49	1·852	1·572	·90	1·053	1·047
·50	1·818	1·555			

It is scarcely necessary to observe, that this same theory applies to the calculation of every kind of steam-engine; and as, in your *Journal* for July, 1850, I find a notice of Sim's Horizoutal Double Expansion Engine, I shall proceed to show how it is applicable to this system of steam-engines. But as a minute detail of the calculation would occupy rather more space thau you could well afford to allot me for such a purpose, I shall confine myself to showing what circumstances have to be taken into consideration in computing the effect of the engine, and then giving the formulæ at once. I shall therefore first consider the effort applied, which will be:—

For the downstroke—the steam acting on the small piston; and for the upstroke—the expanding steam acting on the large piston, minus the expanding steam acting on the small piston.

Whereas the power developed by the various resistances is:—

For the downstroke—the imperfect vacuum acting against the small piston; and for the upstroke—the imperfect vacuum acting against the large piston.

In addition to which, there is, for each stroke, the friction of the uuloaded engine, besides the additional friction owing to the load.

Taking all these items into account, we have:—

$$(4.)\quad v = \frac{\mathrm{S}}{\mathrm{A}} \cdot \frac{2k'}{n + q\frac{1}{\mathrm{A}}[p\,(\mathrm{A}+a) + 2\,(fa + \mathrm{F\,A}) + 2\,(1+\delta)\,\mathrm{R}]}.$$

$$(4^2.)\quad k' = \frac{l'}{l'+c} + \text{hyp. log.}\,\frac{l+c}{l'+c} + \text{hyp. log.}\,\frac{\mathrm{A}\,(l+c) + a\,c}{a\,(l+c) + \mathrm{A}\,c}.$$

$$(5.)\quad \mathrm{R} = \frac{k'\,\mathrm{S}}{q\,(1+\delta)\,v} - \frac{n}{q}\cdot\frac{\mathrm{A}}{2\,(1+\delta)} - \frac{p\,(\mathrm{A}-a) + 2\,(fa \times \mathrm{F\,A})}{2\,(1+\delta)}.$$

$$(6.)\quad \mathrm{S} = \frac{\mathrm{A}\,v}{2\,k'}\left[n + q\,\tfrac{1}{\mathrm{A}}[p\,(\mathrm{A}+a) + 2\,(fa + \mathrm{F\,A}) + 2\,(1+\delta)\,\mathrm{R}\right]$$

for the general case; further:—

$$(7.)\quad v' = \frac{l}{l'+c}\cdot\frac{2\,\mathrm{S}}{a}\cdot\frac{1}{n+q\,\mathrm{P}}.$$

$$(8.)\quad \mathrm{R}' = \frac{l'+c}{l}\cdot\frac{a}{2\,(1+\delta)}\cdot k\,\left(\frac{n}{q} + \mathrm{P}\right) - \frac{n}{q} - \frac{\mathrm{A}}{2\,(1+\delta)} - \frac{p\,(\mathrm{A}+a) + 2\,(fa + \mathrm{F\,A})}{2\,(1+\delta)}.$$

$$(9.)\quad \mathrm{S} = \frac{l'+c}{l}\cdot\frac{a\,v'\,(n+q\,\mathrm{P})}{2},$$

for the case of maximum useful effect; and lastly:—

$$(10.)\quad \frac{l'}{l} = \frac{\mathrm{A}}{a}\cdot\frac{\frac{n}{q} + \frac{1}{\mathrm{A}}[p\,(\mathrm{A}+a) + 2\,(fa + \mathrm{F\,A})]}{\frac{n}{q} + \mathrm{P}},$$

for the case of the absolute maximum of useful effect; where

A = the area of the large piston;

a = the area of the small piston;

F = the friction of the engine unloaded, as apportioned to the large cylinder;

f = the friction of the engine unloaded, as apportioned to the small cylinder; and

R = the total load, not per unit of surface;

all the other notations remaining as before.

If, then, we assume the useful effect of the engine to be equal to 38 horses' power, at the velocity of the piston of 228 feet per miuute, we shall have to put, according to the dimensions given in your engraving,

$\mathrm{A} = 5.586$ square feet—the area of the large piston;

$a = 1.397$ square feet—the area of the small piston;

$l = 3.5$ feet—the length of the stroke.

And since the friction of the parts of the engine cannot be as great as if each cylinder acted independently, and iuasmuch as the vacuum has plenty of time to form itself, I shall assume,

$f = 1 \times 144 = 144$ lbs. per square foot of the piston, as the friction apportioned to the small cylinder;

$\mathrm{F} = 0.5 \times 144 = 72$ lbs. per square foot of the piston, as the friction apportioned to the large cylinder;

$p = 2 \times 144 = 288$ lbs. per square foot of the piston, as the resistance due to the imperfect vacuum.

Finally, I shall assume the steam to be cut off after the piston has performed 2 ft. 6 in. of its stroke, and consequeutly make

$\frac{l'}{l} = 0.714$, whence we derive

$k' = 2.474.$

From what has been said above,

$v = 228$, and

$$\mathrm{R} = \frac{38 \times 33000}{228} = 5500\ \text{lbs.};$$

from which data we shall find

$\mathrm{S} = 0.1982$ cuhic feet of water per minute as the effective evaporation. And if we assume that 1 lb. of coals will suffice to evaporate 10 lbs. of water, we shall find the consumption of coals to be $= \frac{0.1982 \times 60 \times 62.5}{10 \times 38}$

$= 1.956$ lbs. per horse power per hour.

Such is the effect and consumption of this engine under the circumstances indicated; but supposing the total pressure of the steam in the boiler to be 39.71 lbs. to the square inch (25 lbs. exclusive of the atmospheric pressure), and ascertaining the amount of expansion corresponding with the absolute maximum of useful effect with that pressure, we should find, having

$\mathrm{P} = 39.71 \times 144 = 5718.24$ lbs. per square foot;

$\frac{l'}{l} = 0.5$; and therefore,

$v'' = 351.87$ feet per minute for the velocity of the piston, and

$\mathrm{R}'' = 17467.8$ lbs. for the total load.

Consequently, the effect of the engine, with the same evaporation, would be $\frac{351.87 \times 17467.8}{33000} = 186.32$ horses' power.

Although De Pambour's theory speaks for itself, yet it may not be quite useless to show, by some practical examples, how far it can with confidence be applied. I shall, for that purpose, take the liberty of referring to "Tredgold on the Steam-Engine," edition of 1838, Vol. I., page 386, where a diagram, marked No. 3, will be seen, showing the working of the engines of the "Wilberforce," during one of her voyages from London to Hull. It will be found from that diagram, that the average steam pressure was about 3.833 lbs. to the square inch, and that the average vacuum in the cylinder was equal to 12.137 lbs. to the square inch. Adding to the effective pressure of the steam, as found, the atmospheric pressure, the total is 18.543 lbs., the relative volume corresponding to which is 1363. And as it is further stated, that the velocity of the piston was 228 feet per minute, and the area of the piston 19.632 square feet, we have

S $\frac{228 \times 19.632}{1363} = 3.284$ cubic feet of water per minute for the vaporation.

Inserting this value in formula 2, and putting, according to the data above given,

$a = 19.632$;

$v = 228$; also,

$\frac{l}{l+c} = 0.952$ (the engine working without expansion, this value is to be substituted for k, as already mentioned.)

$\frac{n}{q} = 164$, the engine being a condensing one;

$f = 0.5 \times 144 = 72$ lbs.

$p = [14.71 - 12.137] \times 144 = 370.512$ lbs.

$(1 + \delta) = 1.14$,

we find

$a\,r\,v = 8248157.38 = 249.94$ horses' power.

This result certainly differs from that obtained by the calculation of the diagram, as explained at page 387; but it will at once be perceived, that if the factors $\frac{l}{l+c}$ and $\frac{1}{1+\delta}$ be neglected, and the total friction of the engine taken at $2 \times 144 = 288$ lbs. per square foot of the area of the piston, we shall obtain 274.15 horses' power for the useful effect of the engine, the difference of 1.35 horses' power, arising from the circumstance of the volume of the steam having been taken from the table, instead of being calculated according to the formulæ $\frac{1}{n + q\,l^2}$. It may be observed, in this place, that in calculating the useful effect of steam-engines from indicator cards, the additional friction owing to the load should be taken into account, since an error of 30 horses' power out of 273 horses' power is rather too serious to be passed over in silence. In the diagram No. 3, for instance, we should have

$$13.97 \times 2827 \times 228 = a\,v\,(1 + \delta)\,r;$$

therefore, by dividing the product of $13.97 \times 2827 \times 228$ by $a\,v\,(1 + \delta)$, we shall obtain the load r of the engine per unit of surface; $a\,r\,v$ being the useful effect in lbs. raised one foot per minute, which, divided by 33000, gives the effect in horses' power. In calculating the evaporation, account must also be taken of the clearance, as without that precaution the evaporation will be assumed less than it really is; and in all cases the term S must represent the effective evaporation only, any losses from escape of steam by the safety-valves, or otherwise, having been previously deducted from the gross evaporation.

The proof I have above given, confirming, in a satisfactory manner, the correctness of De Pambour's theory, I wish to show under what circumstances the application of large cylinders, especially in locomotive steam-engines, is attended with advantage. You are aware that at one time large cylinders were universally resorted to, and probably not without good reasons, for the increase of traffic on railways must have required more powerful engines. At present, I understand, there is a tendency to return from the 17-inch to the 15-inch cylinders, because it was found that the relative consumption of fuel had rather increased than otherwise. It is not difficult to show, by means of the equations above given, what takes place in reference to this matter; for on comparing two engines working exactly under the same circumstances, and with the same amount of evaporation, the one with a 15-inch, and the other with a 17-inch cylinder, and the steam cut off by the link motion, or other ordinary means, at 5-8ths of the stroke, we shall find—

For the 15-inch cylinder.	For the 17-inch cylinder.
Making S = 0.5	S = 0.5
$v = 200$	$v = 200$
$k = 1.355$	$k = 1.355$
$p = 2118$	$p = 2118$
$f = 144$	$f = 144$
$a = 1.227$	$a = 1.576$
$a\,r\,v = 1963948$	$a\,r\,v = 1787612$

showing an advantage of the small cylinder over the larger one to the extent of 176336 lbs. Whereas, if by a variable expansion gear the steam were, in the 17-inch cylinder, to be cut off so much earlier as its capacity is greater, say at about 0.486 of the stroke, we should obtain, with $k = 1.579$, $a\,r\,v = 2214768$; showing an excess of 250820 lbs. in favour of the 17-inch cylinder, although the evaporation, or amount of fuel consumed, remains the same. With these results before us, it may perhaps be permitted to inquire, whether it would not be preferable to go to some additional trouble in trying to make use of the least objectionable of the expansion apparatus at present known, rather than to return to the small cylinders, with the certain prospect of having to make another change in the opposite direction before long, and to continue, unnecessarily, to consume large quantities of coke in the meantime. It is scarcely necessary to observe, that in the above examples I have assumed the resistances as those belonging to the ordinary non-condensing engines, a circumstance which cannot affect the comparative results, as the engines are supposed to work at equal velocities, and with the same evaporation.

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RECENT PATENTS.

MANUFACTURE OF IRON AND OTHER METALS.

Henry Houldsworth, Esq., *Coltness House, Lanarkshire.—Enrolled Feb.* 28, 1851.

Until very recently, the enormous waste of fuel constantly going on in the free escape of the heated gases from the tops of blast furnaces, was either unheeded or quietly set down to be unavoidable. When, however, it was demonstrated that out of every thirteen tons of coal put into the furnace, not less than twelve were absolutely wasted by dissipation in the shape of escape gases, practical iron-makers began to cast about for a remedy. We need not here refer to the immense variety of schemes thus arising, except to mark the extraordinary economy which followed the successful application of the intercepted gases for heating steam boilers, and producing the hot-blast for the furnaces. Mr. Houldsworth has now found a new use for them, which promises at least to rival all previous ones in the economy of its results. He makes the furnace calcine its own ironstone and lime. The gases, tapped off by a ring of apertures near the top of the furnace into an annular flue in the thickness of the wall, are conducted, by suitable horizontal ducts or pipes, to a main running alongside the range of calcining kilns. From this main, two branch pipes pass to each kiln, the gases being first passed either through or over a small furnace for ignition with an admixture of atmospheric air. In this state the flame and heated products are passed into an annular flue, encircling the base of the calcining kiln, from which flue a set of openings admit the flame and heat to the body of ironstone to be roasted. Or, instead of this arrangement, the gases may be ignited in the interior of the calcining kiln, without the use of

any external fires. In the patentee's drawings, one furnace is represented as supplying four kilns with the heat necessary for calcination. This range of kilns, placed on the bank, at or near the level of the furnace tops, are supplied with raw ore by openings in the top of each kiln, the waggons of ore being conveyed along the line by an overhead railway. The necessary draught through the kilns is obtained by a chimney commanding the whole series, each kiln having a flue connecting its top with a horizontal main flue opening into the chimney. The plan is in successful operation at the Coltness Iron Works, where it is most effective in producing thorough calcination of the ore. The patentee also proposes to calcine the limestone for his furnaces in a similar way. When the process gains a more extended introduction, we shall furnish a statement of the economical results.

INLAND NAVIGATION, AND RAISING HEAVY BODIES.

W. Watt, Esq., *Glasgow.—Enrolled Feb.* 13, 1851.

The first portion of Mr. Watt's invention relates to a novel mode of working canal locks, so as to pass the traffic through them at a greatly increased speed, and at a more economical rate than at present. The arrangement is directly applicable to ordinary locks; the lock chambers and gates being constructed in the usual manner, with the exception of the sluices and water-ways, which, in the improved plan, are dispensed with. The patentee has represented his plan as applied to a pair of locks, considered either as the whole, or a portion, of a chain or series in the line of a canal.

Near each lock chamber is placed a cast-iron receiver or detached tank, at or near the level of the canal, or the bottom of the chamber to which it is applied. This tank or receiver is closed at the top, and is large enough to contain the amount of water necessary to elevate the water-level in the chamber, from the lower to the higher level. The bottom of the receiver communicates with the bottom of the chamber by a wide pipe, and its upper surface is in communication with an air main, or line of pipes, laid alongside the chain of locks. This main is in connection with a suitable air-receiver or magazine, for containing a supply of compressed air, pumped or forced into it by any suitable moving power, as a small steam-engine or water-wheel. When the lock chamber is empty—that is, when the water-level in it coincides with the level of the lower reach of the canal—the receiver or tank alongside is full of water, which water is to be used in the elevation of the level in the chamber, when a boat is to be passed up the lock. In this action, the boat being floated into the chamber in the ordinary manner, compressed air is admitted from the side pipes to the top of the tank, so as to act on the surface of the water, and, by depressing it, force it through the bottom communicating pipe into the lock chamber. This is continued until the water is elevated to the required level in the lock chamber, when the air supply is cut off, and the upper pair of gates being opened, the boat is floated out to pass onwards in the higher level. The chamber thus filled in the upper passage of the boat, is now ready for any boat which may be in readiness in the upper level. The boat being enclosed in the chamber in the usual way, an air-discharge valve in the top of the tank is opened to let off the compressed air contained in it, so as to allow the water in the chamber to flow back into the tank, thus bringing the water-level in the chamber to the level of the lower reach, when the boat is passed out as before.

In working two or more chambers in connection, as in a chain of locks, the patentee has contrived an ingenious plan for economising the power expended in elevating the water-level in the lock chambers, by putting the upper surfaces of any two tanks into communication by an intermediate pipe. When this is done, the compressed air in the empty tank of the full lock carrying the descending boat, rushes into the top of the full tank of the empty lock, taking up the ascending boat, until an equilibrium is formed by the water-level in the descending chamber being brought half-way down, and that in the ascending chamber half-way up. The remaining air is now discharged by the proper valve from the tank of the descending lock, to carry its water-level through the remaining half descent, whilst an additional supply of compressed air is conducted from the main into the tank of the ascending lock, to complete the required elevation of the water-level there. It is obvious that, by this elegant arrangement, one-half of the supply of compressed air is economised at each lift, and the same principle may be carried out throughout the series.

Mr. Watt's drawings show how his plans may also be applied to several other operations, as the lifting and lowering of goods, the discharging of ships' cargoes, raising ships into dry docks for repair, and similar uses.

As we shall shortly have an opportunity of fully illustrating these various applications, we need not at present explain them further than to state, that the main principle already explained is the leading feature of them all.

REGISTERED DESIGNS.

TRICOLOR HAND-SIGNAL LAMP WITH REVOLVING LIGHT.

Registered for Mr. H. A. Holden, *Suffolk Street, Birmingham.*

In the common hand-signal lamps, it has hitherto been the practice to put in clear glass in the outer case, and the red and green glasses in the inner one. The glasses are bent to the circular form of the case, and the change of signals is effected by turning round the inner case until the desired colour stands between the clear glass in the outer case and the light in the interior. In this movement the glasses are very liable to fracture, perhaps at a moment when it is essentially important to preserve the proper signal. It is to avoid this objectionable feature that Mr. Holden has devised his new "Tricolor Hand-Signal Lamp."

Fig. 1.

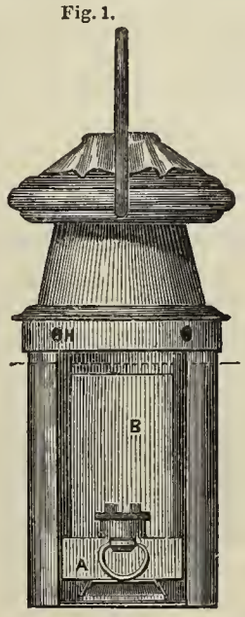
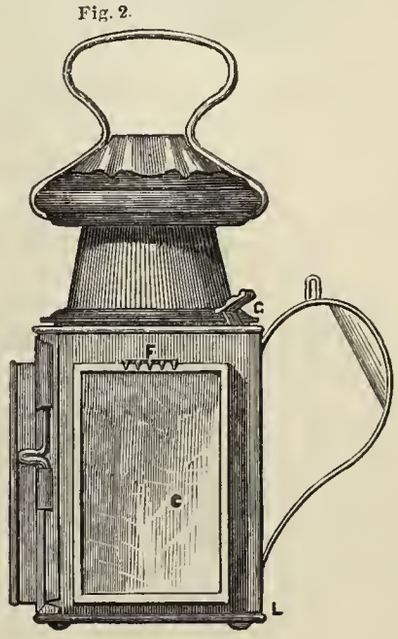


Fig. 2.



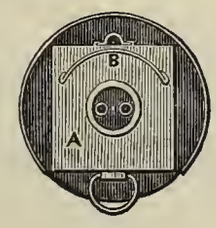


Fig. 3.

1-4th.

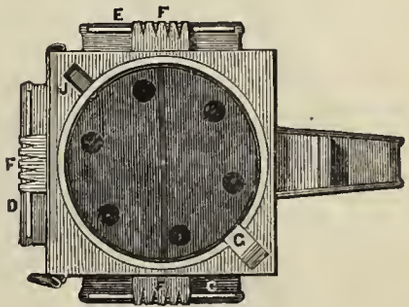


Fig. 4.

Fig. 1 of our engravings represents a side elevation of the lamp complete, showing, as in the original drawing, the red glass turned from the light. Fig. 2 is a corresponding front view of the inner case, at right angles to fig. 1. Fig. 3 is a horizontal section of the same; and fig. 4 is a plan of fig. 1, with the inner case removed.

The oil chamber is at A, being contrived to draw out, for the convenience of cleansing and trimming; B, is the reflector. The upper edges of the three—red, clear, and green—signal-glasses, are respectively represented at C, D, E, in the plan, fig. 4. They are held in their places by the overlaps, F, which can be easily raised to admit fresh glasses in cases of fracture. At G, in figs. 1 and 4, is a slight spring, for retaining the inner case in its position, and to secure it at the proper point of its revolution for showing the right colour; the holes, H, receive the spring, J, acting as a detent, when the required turn has been made.

As arranged in the plan, fig. 4, the lamp is understood to show the clear light, the colourless glass, D, being opposite the stream of light directed from the reflector, B, through the side opening in the inner case. To change the light to the red or green, the inner case is turned a quarter

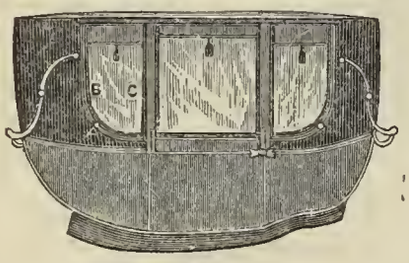
round, when the light is of course reflected through the corresponding glasses. The lamp has a handsome appearance, and the adjustment for the different signals is easily made, and with perfect certainty of action.

LANDAU CARRIAGE BODY.

Registered for Mr. Thomas Fuller, *Carriage-Builder, Bath.*

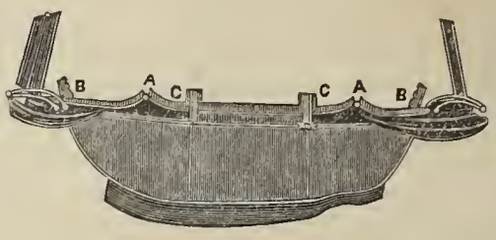
Mr. Fuller has contemplated a twofold object in carrying out this design. In the first place, he has so arranged it that the points of the roof, when open, are thrown more forward and backward, so as to be entirely clear of the heads of the persons inside. In the second, he has introduced additional side glasses, as fully delineated in fig. 1 of our engravings. These illustrations represent, in fig. 1, the "Landau Carriage Body," as closed, and in fig. 2, the same in its open form.

Fig. 1.



The hinges, A A, upon which the front and back portions of the head are folded, are placed considerably further towards the back and front of the carriage than hitherto, for the purpose already explained; and with this view additional rails, B B, are employed in the formation of the body, admitting of the introduction of the additional side glasses, C C.

Fig. 2.



In the open position of the body, the occupants have thus a much more convenient sitting accommodation, whilst the side glasses need no explanation of the superiority which they afford, as they show it for themselves in our illustrations.

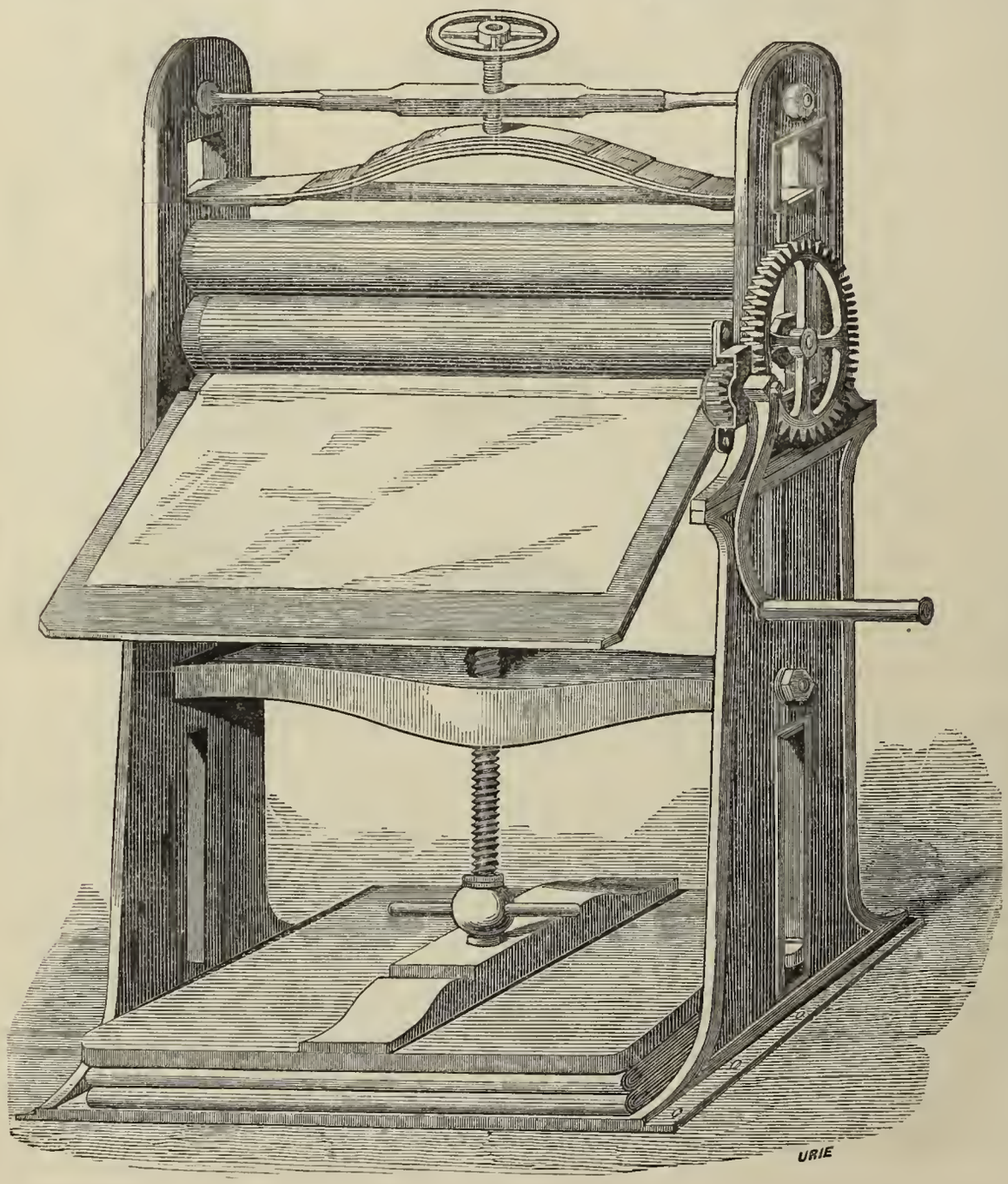
COMBINED MANGLE AND CLOTHES PRESS.

Registered for Messrs. E. O. and L. Tindall, *Scarborough.*

Our large engraving exhibits a perspective view of this convenient combination of two hitherto separated pieces of domestic machinery. The mangle itself is similar in its general details to the "Domestic Mangle," illustrated at p. 33 of the second volume of this *Journal*, with the addition of wheel and pinion gearing for driving the rollers. It is easily adapted for wringing purposes, by removing one of the three rollers.

The addition of the press beneath, is a very important feature in the arrangement. It is compressed within the space allotted to the lower framing, or standards of the apparatus, and, of course, fills up room which would be otherwise unoccupied.

This mangle formed one of the articles exhibited at the recent collection of novelties at the Society of Arts.



GAS COOKING RANGE.

Registered for Mr. Alexander Graham, *Eagle Hotel, Glasgow.*

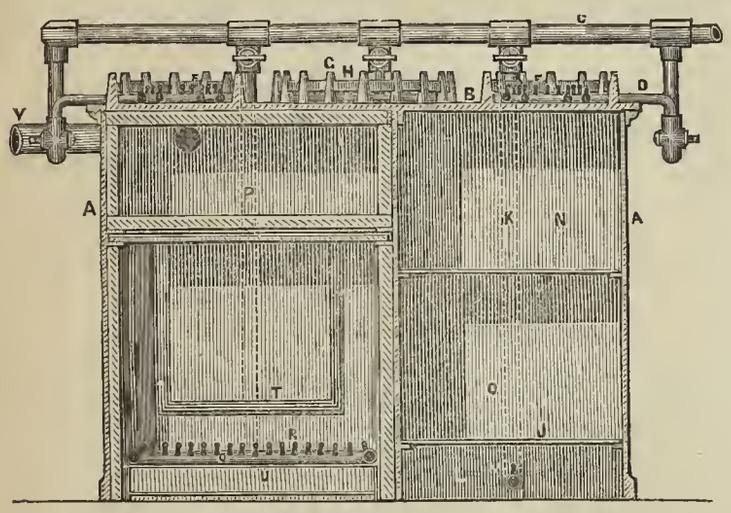
The economy and cleanliness attending the applications of gas in cooking operations, promise to bring about the very general introduction of this convenient heating power. Of the various proposed plans of this nature, that of Mr. Graham appears to offer peculiar advantages, as it admits of all the different treatments in use in cooking being carried on simultaneously in one apparatus, and with an economical result hitherto, we believe, unequalled.

Fig. 1 of our engravings represents the range in vertical sectional elevation. Fig. 2 is a corresponding plan.

It is composed of two cast-iron end plates, A A, with a corresponding back plate of the length of the range, and a top plate, B, the front being covered in by three doors. The gas is led from the main by the pipe, C, from which seven branches are conducted to a corresponding series of burners inside and on the top of the range. The five branches, D, lead to three different sizes of burner scrolls, intended for boiling or heating vessels placed

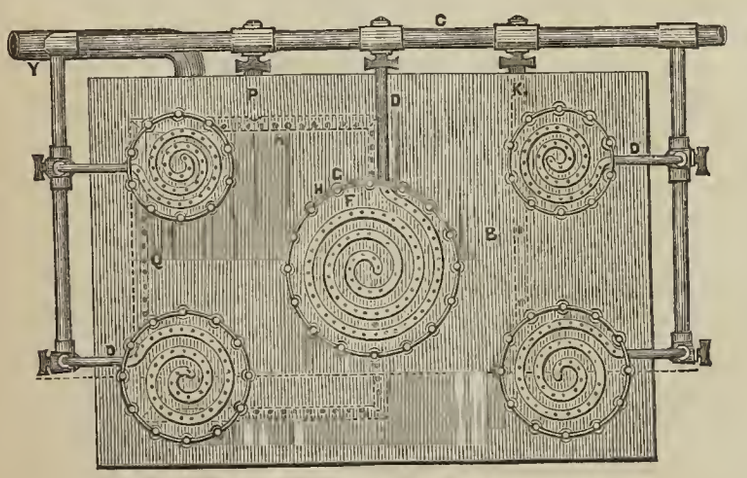
on the top of the range. Each pipe passes close over the top of the range, and the terminal volute, E, rests on the surface. It is studded throughout with small gas-burners, F, and is surrounded by a ring of studs, G, standing up from the top of the range. These studs stand up a little higher than the burners, and are connected together by a flat metal ring, H, which retains the heat from the burners, and guards them from contact with atmospheric currents. The vessel to be heated is placed on the ring of supporting studs corresponding to its size, and the gas flames from the burners are thus brought into close contact with the vessel's bottom. The internal space is divided into two unequal

Fig. 1.



portions by a vertical division plate, I, and the smaller space is again divided into three portions by the moveable slides or shelves, J. A branch, K, from the main gas-pipe, C, is bent downwards, and passes into the bottom space, L, terminating in a short horizontal piece carrying the burners, M. The heat from these burners, in its ascent, warms the chambers, N O, which answer as receptacles for plates, or food to be kept hot. A single door closes up this side. The larger division has a branch, P, led into it from the pipe, C. It enters near the bottom, and

Fig. 2.



1-16th.

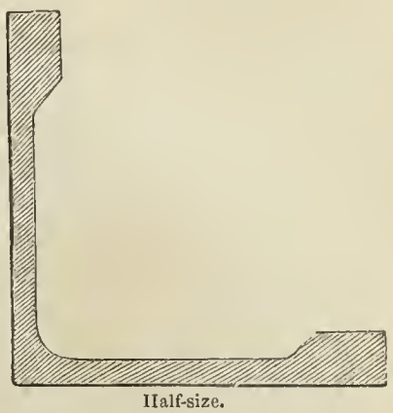
terminates in the rectangular burner tube, Q, studded with a series of burners, R, inclined inwards as represented. From the division plate, S, above, a wire frame or netting, T, is suspended to carry the meat to be roasted, the gravy or dripping falling into the bottom receiver, U. The upper division, V, is an oven, which is heated by the same burners, R. The whole of this roasting and baking side of the range is lined with fire-brick, W, which collects and radiates the heat from the burners upon the articles being cooked. The bottom of the oven, V, is also lined or covered with fire-brick, X, which is heated by radiation from below. The whole of the arrangements of burners are regulated by stop-cocks, and each burner is made with a very minute gas aperture, to economise the consumption. The heated air and vapours escape from the oven by the waste pipe, Y.

For this very comprehensive apparatus may be safely claimed the important points of superior economy and cleanliness in action, as well as the more effective preparation of food, and the non-exposure of the cook to the injurious effects of an over-heated atmosphere. A dinner for forty people has been cooked by it, with an expenditure of sevenpence worth of gas.

NEW FORM OF ANGLE IRON.

Registered for Mr. W. A. Adams, *Midland Works, Birmingham.*

Under this title, Mr. Adams, the well-known railway carriage builder, has introduced an ingeniously-contrived modification of the common angle iron for giving increased strength to the under frames of waggons and carriages. The great objection to the use of the ordinary form of iron for purposes of this kind is, that it does not stand an end thrust. The ordinary timber sole-bar of a waggon is of very formidable dimensions, being from 10 to 12 inches deep, and from 3½ to 5 inches thick. In his experiments recently made, for the purpose of ascertaining how far the size and weight of this part of the framing could be diminished, the inventor has struck out this new form of angle iron, as a substitute for the wooden bar.



Half-size.

Our engraving represents a transverse section of one proportion of the iron, which he considers to give the best results, with the least weight of material. In it the strength is at the parts farthest from the imaginary centre of the bar, whilst it presents a square face at the side and bottom. A set of waggons are now being constructed with the iron thus thickened at the edges, as a practical test of the presumed advantages of the new form. A very important advantage in the way of durability, is expected to arise from the substitution of iron for wood. English oak, admitted to be the most suitable material at present in use, is not procurable, in a thoroughly seasoned state, in anything like sufficient quantities, so that, after making up, it is subject to constant change. So far Mr. Adams has confined his investigations to the application of iron to the principal portions of the under-frame, but he proposes shortly to carry out his proposition in the other details.

CORRESPONDENCE.

THOMSON'S IMPROVED WATER-WHEELS.

We now give Dr. Schinz' letter referring to Mr. Thomson's improvements, as mentioned last month in our abstract of the specification of the patent. We also add a note on the same subject by Professor Wm. Thomson. Both statements give a very favourable account of the invention:—

"When I attended the meeting of the British Association in Oxford, I communicated to the Mechanical Section some observations on the importance and frequent application of horizontal water-wheels, so called Turbines, in Switzerland.

"I pointed out the great advantage they possess in their principle, in being applicable for any height of waterfall, and in requiring no heavy gearing for bringing up the speed to what is commonly required, on account of the great rapidity of revolution at which they work to the greatest advantage.

"I had also the honour to call the attention of the Mechanical Section to two kinds of turbines brought into operation a few years ago, in Alsace and Switzerland.

"One is remarkable for the principle of a suction-pipe, by which the pressure of the air is taken away fully or partly from the back of the vanes of the wheel, so that the velocity with which the water rushes through the directing or fixed vanes upon the wheel placed beneath, is determined by the sum of the column of water above, as well as beneath, the wheel. This disposition gives the advantage of enabling the engineer to place his wheel at any convenient distance, less than 32 feet, from the lower water-level.

"The other involves the principle of injecting the water from the outer circumference of a horizontal wheel in a tangential direction, so as to cause the water to rush towards the centre of the wheel in losing all its tangential motion, by pushing the curved vanes of the wheel forward. Whilst, in the turbine of Fourneyron, the water being injected at the interior, leaves the wheel with a very considerable velocity in relation to the wheel, and causes, therefore, a considerable friction; this

wheel, with outside injection, is left by the water having, as it were, no horizontal motion at all, and therefore no appreciable friction from this reason.

"Both of the above-mentioned principles have been carried out in great variety of height and power, giving, in almost every instance, very satisfactory results.

"I am now happy to say, that a very careful inspection has convinced me of the merits of the suction-wheel of Mr. James Thomson of Glasgow College. It combines in a most favourable way the two above-mentioned principles of suction and exterior injection, though it is altogether different from the wheels in which those principles have been employed.

"The utmost velocity attained by the water in this turbine, is that due to half the height of the disposable waterfall; and from this cause the friction is much less than in other turbines, in which the water usually attains, at two successive times, the velocity due to the whole fall. Once being in the wheel, the water will meet in no way with any appreciable kind of friction or collision, as it runs gently through the vanes and suction-pipe without any admixture of air, the force of suction being balanced by the centrifugal force. This gives the wheel, so far as I am aware, a superiority above all the existing water-wheels. The regulation of the required supply of water is easily carried out, and is made self-acting by ingenious but simple mechanism.

"I am able to state, that I took part in several experiments made upon a model of the above-mentioned suction-wheel of Mr. Thomson, calculated to work at about one-tenth of a horse power.

"Great care was taken in measuring exactly the height of the waterfall really employed, as well as in measuring the supply of water used.

"I calculated that the uncertainty of the result, arising from the faults in estimating the mechanical action of the water itself, could not amount to more than one per cent.

"As a dynamometer, a well-constructed *frein dynamométrique* of Prony was applied, whose indications were to be considered sufficiently exact, as it appeared very steady in the course of the observations, each of which lasted for something more than ten minutes.

"Two of the observations gave the following data:—

	First Experiment.	Second Experiment.
Height of the head,	4 feet 3·75 inch.	4 feet 3·375 inch.
Quantity of water,	1,100 imp. galls.	1,100 imp. galls.
Number of revolutions,	1,155.	1,140.
Weight depending from the end of the lever of the dynamometer,	5·5 lbs.	5·5 lbs.
Circumference (this lever being radius),	6 feet.	6 feet.

"My calculation gives:—

	First Experiment.	Second Experiment.
Mechanical action of the water,	47,437 ft. lbs.	47,094 ft. lbs.
Mechanical action of the wheel,	38,115 ft. lbs.	37,620 ft. lbs.
Therefore, the number of per cents rendered useful by the wheel,	80·35.	79·89.

"The mean of both gives 80·1 per cent. of mechanical action obtained from this model, which, being made of tin-plate, had some imperfections in its construction that injured its action. This is certainly a result of the most satisfactory description, and which may be easily surpassed by a more careful execution of the elaborate details laid down by the inventor.

"There is another invention of Mr. Thomson he calls a ease-wheel, different in form, but nearly according to the same principles. It is also very easily regulated, and contains, besides, in its own principle, a certain kind of regulating power; the increased centrifugal force of the wheel being able to check the supply of water to a certain extent, when it has less work to do. This is a property which may prove valuable, as it enables the regulator to be dispensed with, which is in most wheels very expensive, where some latitude in velocity is granted, and when the supply of water is abundant.

"DR. EMIL SCHINZ,

"Professor of Natural Philosophy and Mechanical Arts in the College of Aargau, in Switzerland.

"*Edenbarnet, Sept.* 12, 1847."

"I have examined with care the principles and construction of the new horizontal water-wheels, invented by my brother, Mr. James Thomson; and it seems to me that, in these machines, the best possible means are taken for obtaining mechanical effect from a given fall of water.

"In any water-wheel whatever, only a per centage of the work due to the entire fall can be obtained; but if the water be introduced into the wheel without shock, be allowed to pass through it in a continuous mass, with no violent rushing, and be discharged with a very small velocity through a sufficiently large channel or pipe, the adaptations being in other respects good, the loss will be as slight as possible. The principles adopted by my brother in his wheels are in entire accordance with these conditions, so that the various sources of loss, which in other water-wheels arise from the violation of some of these conditions, are in the new wheels almost entirely avoided.

"Besides the general fulfilment of the above-mentioned essential conditions for a good machine, there is, in the new water-wheels, a very remarkable adaptation, according to which, by the balancing of the contrary fluid pressures due to half the head of water, and to the centrifugal force in the wheel, only one half (instead of the whole, or more than the whole, as in most of the turbines already known to the public) of the work due to the fall is spent in communicating *vis-viva* to the water, to be afterwards taken from it during its passage through the wheel; the remainder of the work being communicated through the fluid pressure to the wheel, without any intermediate generation of *vis-viva*. By this important arrangement, the velocity of the water where it moves fastest in the machine is very much reduced; and the loss due to the retarding action of channels or passages, which cannot be entirely removed in any hydraulic machine, is thus diminished to a remarkable degree. In this valuable characteristic, the new water-wheels have a great superiority over the best turbines of Fourneyron or Poncelet.

"I have seen experiments made with models of the various modifications of the new wheels. These models worked in an extremely satisfactory manner, and gave a very high per centage of the total work due to the water. In making trials of water-wheels, experimenters have frequently obtained results indicating very high per centages of work, in which they have been deceived from various causes of uncertainty or error; especially by the methods they have adopted for measuring or estimating the quantity of water used. In the present case, however, I consider that entire confidence may be placed in the experimental results.

"I have no hesitation in expressing it as my opinion, after most mature consideration, that, both in convenience and in efficiency, the new water-wheels are superior to all other horizontal water-wheels which have been brought before the public.

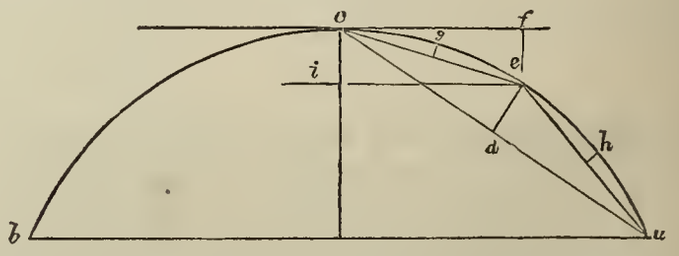
"WILLIAM THOMSON,

"Professor of Natural Philosophy in the University of Glasgow.

"*Glasgow, March*, 1848."

ON SETTING OUT RAILWAY CURVES.

Amongst various methods of laying down moderately large circular ares, which are given in elementary books, I have never happened to see the following; but as I cannot boast of very extensive reading, it may be well known—indeed, as it depends on a property of the circle, it must be known to mathematicians; still there are many who are ignorant of it, and should you deem it worthy of a place in your magazine, it may be valuable to them, as it combines the greatest simplicity with perfect accuracy. I stumbled on it after having several times used the somewhat similar but incorrect method of quartering the versed sine of the whole are to find that of half the are, an approximate rule which is only admissible in flat curves, and for rough purposes.



It is presumed that the chord and versed sine of the are are given. Let $a\,b$ be the chord, and c the central point of the are. From c draw a straight line, $c\,f$, parallel to $a\,b$, forming a tangent to the required are; draw another straight line, $a\,c$, and bisect it in d; from which point raise a perpendicular, $d\,e$, and on this line find a point, e (practically by trial, or geometrically by bisecting the angle, $d\,c\,f$), equidistant from the lines $a\,c$ and $c\,f$; e is a point in the are required. In the same way another point at g may be found, by drawing the line $c\,c$, and proceeding as in the case of $a\,c$; then, as the segments $a\,c$ and $c\,c$ are equal, a point at h may be found by making the height of the perpendicular or versed sine at h, from the chord $a\,e$, equal to that at g; and so on until a sufficient number of points are obtained, through which the curve may be correctly drawn by bending a lath or otherwise.

It is so evidently correct in principle, that proof is almost unnecessary; for draw $e\,i$ parallel to $f\,c$, $c\,i$ is the versed sine of twice the are $c\,c$, and $d\,e$ is the versed sine of an are equal to twice that are; but $c\,i$ and $d\,e$ are equal, because they are each equal to $e\,f$, consequently the curve is regular, and e a point in the segment of a circle passing through the points $a\,c\,b$.

Manchester, February, 1851. G. H. S.

NOVEL PADDLE-WHEEL.

My sketch annexed, represents a steam-boat paddle-wheel, invented by me several years ago, but still untried. As many practical engineers have expressed a favourable opinion upon it, it may perhaps be not unworthy a place in the pages of the *Practical Mechanic's Journal*. The sketch gives a longitudinal section of a steamer, showing the paddle-

wheel in side elevation. One wheel only is used; it is placed in the centre of the boat, the bottom of which is open to admit a part of the paddle to project through. The centre wheel is covered with an air-tight paddle-box, the crank shaft being passed through its sides by suitable stuffing-boxes, and driven by a crank on each end. The paddle-box is connected by a pipe to a small condensing air-pump, worked by a small engine for the purpose. Air is forced into the bore by the pump until all the water is displaced from it, so that the paddle works in an atmosphere condensed to a pressure equal to that due to the surrounding head of water, or the draught of the boat, and the portion of the wheel projecting through the boat's bottom, works in still or dead water, where there would be no slip, nor even any back-water. It is presumed that the paddle floats would work into the still-water like the teeth of a wheel in a rack.

To protect the paddle from damage beneath, I would fit a couple of side keels, or fenders, to guard it. Such a paddle would not, I believe, require to be more than one-half the diameter of the existing wheels. The plan would answer equally as well for large as for small boats, as with increased draught of water we get an increased resisting power or hold for the paddle floats.

JAMES BRAIDWOOD.

Johnstone, Feb., 1851.

CORROSION OF CAST-IRON PIPES.

I notice, in the *Practical Mechanic's Journal* for February, an inquiry from a correspondent, signing A. S., for the best sort of service-pipe for water. I beg to suggest the patented coating for water-pipes of Dr. Robert Angus Smith of this town. By certain combinations of suitable matters, he has succeeded in rendering water-pipes incorrodible by water or gas, and with the further advantage of preserving the water free from iron or lead. On inquiry from the Manchester Corporation, who have thus coated all the mains and service-pipes of the New Water Works, your correspondent will, I think, receive a satisfactory answer.

JAMES HIGGIN.

Manchester, Feb., 1851.

IMPROVEMENTS IN MINE MACHINERY.

As I have recently seen, in the *Practical Mechanic's Journal*, several improvements in this class of mechanism, I shall, perhaps, not presume too far upon your attention, by giving you an outline of my own arrangements of this nature, as prepared several years ago. According to my plans, for which the Royal Scottish Society of Arts awarded me their £30 Keith gold medal in 1845, "overwinding" is rendered impossible. The full corve or waggon is taken from the pit-mouth, and run down an inclined plane to the attendant placed at a distance from the shaft, and the empty corve is run up the incline, and sent down the shaft, entirely by mechanical appliances. A drawing and description of my plan will be found in the published Transactions of the Society for the year 1845. I annex a copy of the Society's report.

DANIEL ERSKINE.

Edinburgh, Feb., 1851.

"Mr. Erskine states that the object of his improvement is to prevent the ropes of coal-pit engines from being overwound, and to prevent the many accidents occasioned by the buckets being carried over the pulleys; and also to remove the attendants from the *mouth* of the pit.

"The engine and machinery invented by Mr. Erskine for these purposes, not only accomplish what was intended, but do so in the simplest and most efficient manner; and the means by which each separate operation takes place, is, in itself, simple; and the peculiar movement employed for each purpose is one of the most judicious that could be selected.

"The committee are also of opinion that many of the contrivances display originality, and that Mr. Erskine possesses ample mechanical resources.

"That, as a whole, it is a mechanical composition of no ordinary merit; and that the beautiful working model is produced in a degree of perfection and maturity not often to be met with in similar contrivances.

"The engine is self-acting, and, after winding the bucket or waggon from the bottom of the shaft, by a simple and ingenious mechanism it is carried some yards from the mouth of the pit. By a second very ingenious contrivance, the steam is shut off, and the engine stopped or reversed. By which means, those most distressing accidents that occur from overwinding would be greatly diminished, if not altogether prevented; and the great expense consequent upon the damage done to the machinery, and the stoppage of the works during repairs, would be completely saved.

"We therefore consider Mr. Erskine's new method of taking the buckets from the mouth of coal-pits, and shutting off the steam from the winding-engine,' as peculiarly a subject suited to the purposes, and deserving the marked encouragement of this Society.

(Signed) "GEO. GLOVER, *Convener*

"*Edinburgh, 23d June*, 1845."

SUSPENSION BRIDGES.

I observe, in your *Journal* for February, 1851, at page 261, some questions put by "R. B." as to the cause of the giving way of suspension bridges, from time to time, in our own country and in France, "when it is invariably stated that they will bear at least six times as much (load) as they will ever be required to sustain."

If your correspondent will consult the Transactions of the Royal Scottish Society of Arts, Vol. I., page 304 (which he will probably find in the library of the Philosophical Society of Glasgow), he will there find an interesting paper on the subject, by Mr. Scott Russell, of 16th Jan., 1839, going minutely into the cause of the destruction of suspension bridges from the effects of vibration, or vertical oscillation; and suggesting a method of preventing their destruction from that cause, by placing stays, not at regular, but at irregular, distances.

JAMES TOD,
Secy. of the R. S. Society of Arts.

Edinburgh, Feb. 1851.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—TWENTIETH MEETING.—EDINBURGH, AUGUST 1, 1850.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

"On a Tissue woven by Caterpillars," by Mr. J. Dennistoun.

In the early part of this century there lived at Munich a retired officer, Lieut. Hebenstrait, who amused himself by experiments on the means of giving consisteney to the gossamer produced by caterpillars, which is occasionally seen blown about in flakes over the fields in Germany, and he was at one time sanguine of rendering it available as a material for ladies' dress. It is said that his plan was to prepare a paste of lettuce or other leaves beat up with butter, and after spreading it thinly over a smooth surface of stone or wood on an inclined plane, he placed at the lower end a number of chenilles or caterpillars of the proper species. These animals gradually ascended the incline, devouring the paste, and depositing as they proceeded a sort of tissue, until the whole surface was uniformly covered with it. He is reported to have produced open-work designs by drawing the pattern with a hair pencil dipped in olive oil before the animals begin to work. These I never saw, but I have seen one veil on which were some letters exactly resembling a watermark on paper, the secret of which I do not know. The inventor pursued his experiments with great secrecy, in the hope of turning his invention to valuable account; but finding this impracticable, it appears that he produced but very few specimens, which are now preserved in various museums on the Continent. I have seen two besides my own, which I procured at Munich in 1837, after having advertised for it several months. The objections to using this tissue seem to be chiefly its exceedingly flimsy quality, and its very adhesive properties, which render its management and preservation extremely difficult, attaching itself closely even to the smoothest surfaces, from which it can be separated only by the breath. My veil is about 42 inches by 24 inches. One, of 26½ inches by 17 inches, is said to have weighed only 1½ grains. Another, containing nine square feet, is mentioned as weighing 4½ grains, while the same surface of silk gauze weighed 137 grains, and of fine lace 262½ grains. It would seem that the art was in some degree known at an earlier period, and occasionally practised in convents, where coloured drawings on small bits of it are said to have been made. I have seen in all four of these on the Continent, and two or three on which impressions from copperplate had been taken, always of sacred subjects. One of the drawings is in my possession, about 7 inches by 5 inches, executed apparently in the last century, and I have seen one dated about 1770.

This beautiful tissue was unfolded to the Section by Mr. Dennistoun and Sir D. Brewster. It was rather more transparent than the finest lace veil, but it floated about with every slight current in the air of the Section-room, after a manner quite its own.

At this stage of the proceedings Sir D. Brewster exhibited to the Section several Talbotypes from negatives on albumen, by Messrs. Ross and Thomson, Edinburgh, and by M. Constant, of Rome; from negatives on paper, by Mr. S. Buckle, Peterborough; and from negatives on gelatine, executed in Paris by M. Bolard.

"On a new Solid Eye-piece," by the Rev. J. B. Reade.

The author stated that he had been able to get rid of the two well-known defects of the common negative eye-piece, viz., a play of false light, and the formation of a false image, or, as it is generally termed, *a ghost* of a planet or star, by simply filling the eye-piece with water. The addition of the water causes the ray of light to pass to the eye without suffering any inner reflections from the surfaces of the lenses of the eye-piece. It also makes the eye-piece positive instead of negative; while, at the same time, the magnifying power remains nearly the same, the magnitude and flatness of the field are preserved, and the achromatism is not disturbed. It is, however, desirable to make the inner surface of the field lens a little convex, as the ray now passes out of glass into water, and not into air. The Astronomer-Royal of Scotland, after trying the eye-piece upon Saturn, double stars and clusters, expressed a very decided opinion as to its admirable performance generally, as well as on the increased blackness of the field, owing to the absence of all false light. To avoid some little trouble arising from the use of water, the

author proposes to substitute glass or rock-crystal for the water, and to cement the surfaces together with Canada balsam; but in this case the inner surfaces of the eye and field lens must have a diminished radius of curvature. It was added that the use of an eye-hole, exactly as in the eye-piece of a Gregorian telescope, is not only desirable, but, for large object-glasses, indispensable. Without it, the aperture of an object-glass must be reduced to three or four inches when turned upon the sun, or the dark glasses will infallibly be cracked; but with it all injurious heat is stopped out, and the full aperture can be used as in the case of a Gregorian of 7 or 8 inches in diameter. This arises from the different refrangibility of the rays of light and heat. In the ordinary use of a prism, it is well known that the rays of heat are less refrangible than the rays of light, and are in fact at a maximum beyond the rays of the spectrum; but when the sun's rays are brought to a focus by means of an achromatic object-glass, the author finds that the point of most intense heat is within the focus of the compound lens. In a direct experiment with a 6-inch object-glass of Tulley's, he found that black glazed paper was not burnt, but only smoked, when held two inches beyond the focus—at 1 inch it took fire in 39 seconds,—at half an inch in 27,—at the focus in 24,—at a quarter of an inch *within the focus* in 11,—at half an inch within in 14,—and at 1 inch within in 19 seconds. Hence it follows, from the different positions of the principal foci of light and heat, that the eye-piece which makes the image rays parallel, leaves the hot rays divergent, and passing to some extent on the outside of the illuminating rays, and the eye-hole becomes essentially important, not only for the general purpose of stopping out false light, but particularly for stopping out all injurious heat during the examination of the sun with large telescopes.

INSTITUTION OF CIVIL ENGINEERS.

Dec. 3, and Dec. 10, 1850

The discussion on Mr. Struvé's paper, on "The Ventilation of Collieries, theoretically and practically considered," was resumed.

The importance of large air-channels in short lengths, for furnishing ample supplies of air under ground, was admitted by several members, who, however, objected to the application of mechanical ventilation, preferring its being effected by natural means, which, it was contended, could be attained by a judicious system of "winning" arrangements. When, however, this was not practicable, Struvé's apparatus was approved as the best hitherto introduced. A somewhat similar, but less perfect system had been used for some years in Germany, Prussia, Belgium, and in some mines in England.

The system of sinking shafts on the dip, for the advantage of collecting water, without considering the tendency of gas to accumulate in the upper cavities of the workings, was deprecated, and the more advantageous plan proposed of having the downcast shaft on the dip, and the upcast on the crop, whereby an easier exit would be provided, and a more effective ventilation be established.

The application of the steam-jet was advocated, and instances were given of its efficiency in clearing the after-damp from pits where explosions had occurred. It was argued, from experiments, that the steam-jet could be rendered much more efficient than the furnace; but no statement of the relative expense of this plan, as compared with mechanical ventilation, was entered into.

The evidence given before the House of Commons in 1835, the House of Lords in 1849, and to the South Shields Committee on Accidents in Coal Mines in 1843, was carefully analysed, with the intention of demonstrating, that beyond certain limits it was useless to force furnace ventilation, as, under certain circumstances, a current of cold air was found to descend the upcast shaft, forming a false brattice, and arresting the ventilation. The steam-jet was stated to be capable of such increase of power, and of such varied application, as not to be subject to this inconvenience.

It was contended, on the other hand, that, in reality, this natural brattice was seldom perceived, and that, when it did occur, the system of scaling off a portion of air, at some distance up the shaft, sufficed to destroy it.

It was shown that mechanical ventilation was essential to clear away the choke or after-damp, so as to enable a mine to be entered after an explosion, when it might be dangerous to light the furnace at the bottom of the pit; but by setting the machine at work with increased velocity, a much greater circulation of air could be caused under any circumstances of barometrical pressure, and the mine could be cleared in a short time. Had this system been adopted, the dreadful effects of the choke-damp after explosions would have been frequently obviated, and much waste of human life might have been avoided.

It was further argued that, like the furnace, the steam-jet, in its application to the upcast shaft, did not produce any pulsation in the current of air which was so very wasteful of the power for giving motion to all means of mechanical ventilation, and therefore, that, by the accepted laws of physics, the steam-jet setting in motion a body of air which continued to flow without intermission through the galleries and the upcast shaft, subject only to the deduction for the pressure of the atmosphere, and the friction of the column of air on the surface over which it passed. It was shown that, to obtain the full and effective action of the steam-jet, precautions must be adopted, in bringing it down a certain distance, so that the jet should act conically, and a variation of the distance between the jet and the extremity, or apex, of the inverted cone, would produce a corresponding variation in the degree of rarefaction. The jet was stated to act equally efficiently either at the top or the bottom of the shaft, although it was admitted to be more costly in the former situation. Its application at the Ebbw Vale Collieries was asserted to be very effective, and as only the surplus steam was employed, it was, in that instance, the most economical system that could be used.

On the other hand, it was contended that, in mechanical ventilation, the pulsation of the air was only perceived where the valves were heavy, or were of contracted area; that, practically, it was more to be relied on than any other system, and that the safety afforded by it was superior to the furnace, or the steam-jet, as, under circumstances of danger, or after an explosion, it could be brought into immediate action with increased energy, to meet the emergency, and be the means of saving human life.

In summing up the discussion, the evidence given before the House of Lords in 1849 was again minutely analysed, with the view of showing that the deductions previously drawn were not correct, inasmuch as the results obtained were owing to temperature, and not to the exhaustion created by the steam-jet. The published opinion of M. Combes—"that the useful effect of the steam employed to produce the motion of the air, by projecting it into a tube, is in all cases much below what it is capable of producing when applied to a steam-engine working mechanical ventilators of the most imperfect description," was quoted in support of these views.

It was considered that a current of air in the upcast shaft, of at least 18 feet per second, was most desirable, to produce which a motive column of air of 137 feet would be requisite, and this could not be attained where ventilation by means of a furnace, or of a steam-jet at the bottom of a pit, was used, without raising the temperature to such a degree as would be impracticable in bratticed shafts, or in shafts used for winding coals, or for the passage of men. It was then shown that the steam-jet, applied at the top of the upcast shaft, and acting merely by rarefaction, would be too costly for general adoption, whereas, if the combined area of the pumps of Struvé's mine ventilator was sufficiently large to equal the aggregate amount of the splittings of the colliery, it would only require one-sixth of one-horse power for every superficial foot of the upcast shaft. It was shown that no pulsation in the current of air was perceptible in the Eagleshush Colliery (where Struvé's mine ventilator had been in use for nearly two years), at a greater distance than 100 yards from the machine, and could not, therefore, extend prejudicially into the workings. It was mentioned that two other machines, similar to those in use at the Eaglesbush Colliery, were in progress of construction for two collieries in the neighbourhood of Swansea.

M. Leteret, an eminent mining engineer, had asserted that no similar machine to Mr. Struvé's had ever been used in Belgium, and that he thought it, both for utility and economy, superior to any mechanical ventilation which had yet been introduced.

At the close of the regular business, Mr. Beckers exhibited and described a self-acting siding-stop, which was now in use on the Great Western Railway. A portion of the ordinary rail was cut so as to admit of the movement of the stop, which was of iron, about 1½ inch thick, and projected above the rail about 9 inches; this was attached to one end of a shaft, and on the other end there was a bent lever, which carried a signal-disc above, and a counterbalance weight below. The object of this simple and inexpensive machine was to remove the liability to accidents from carriages or trucks running out of a siding on the main line, as occurred some time since at Wootton-Basset; for whilst it permitted a train of waggons to pass into the siding, the wheels themselves depressing the stop, it presented an absolute bar to any waggon leaving the siding, unless some person held down the lever so as to lower and remove the impediment.

December 17.

William Cubitt, Esq., President, in the Chair.

The Annual General Meeting for the election of the president, vice-presidents, and other members of council, for the ensuing year, and for receiving the annual report of the retiring council, was held this evening.

The report was rather more explicit than usual; and, whilst congratulating the members on the increased attendance at the meetings, the high value of the original communications, and the practical character of the discussions which ensued on their being read, it urged the necessity of organization amongst the great body of the civil engineers generally, as well for the purposes of professional advancement, as for protection of their interests—their rights and privileges—which had of late been invaded by persons not regularly brought up to the profession. It was shown that, as this Institution was the most natural, so it was the only ready, means by which this desirable end could be properly and effectively carried out, and how absolutely essential it was that it should receive the cordial support of every civil engineer who had the honour and credit, both of himself and of his calling, sincerely at heart. The same necessities which had, many years ago, called this Institution, the first of its kind, into existence, had lately induced the establishment of similar societies in several chief towns of Great Britain; and the spirit had even extended to foreign countries, where the evils of the centralization system, and of the interference of Government boards, had been severely felt: all these societies had taken this, the parent society, as a model in nearly every particular.

The principal papers which had been read were noticed, and their objects and merits explained in a few expressive sentences. For these, the following medals and premiums were awarded:—Telford Medals, to Messrs. Armstrong, W. H. Barlow, W. Taylor, Thorneycroft, the Rev. J. C. Clutterbuck, M.A., Chubb, Turner, and Paton, and Lieut.-Col. Lloyd, and Professor Cowper; and Council Premiums of Books to Messrs. Neate, Hood, Mallet, Doyne, Paterson, Poingdestre, and Lawrence.

The finance statement exhibited, in some respects, an improvement over the last year; the current subscriptions were more closely paid up, and an accession of funds, to the extent of nearly £3000 stock, from the division of the residuary estate of the late Mr. Telford (the first president and founder), had been recovered, in the month of August last, from the Court of Chancery; and for this the Institution was in a great degree indebted to their late president, Mr. Walker, in whose name the suit had been carried on, and had finally been brought to a successful issue.

Though the deceases and resignations were more numerous than usual, there had been an increase in the number of members, which now amounted to six hundred and eighty-one of all classes. The deceases included the names of many gentlemen eminent in their profession, and of that great statesman, Sir Robert Peel, whose untimely end, not only this country, but the world at large, so deeply deplored, and who had shown a marked desire to advance the interests of the Institution, and to bring forward its officers on all occasions. Memoirs were read of the Right Hon. Sir Robert Peel, Bart., M.P., Honorary Member; Sir M. I. Brunel, J. A. Galloway, J. Gibb, W. Handiside, Colonel Irvine, C.B.B.E., G. T. Page, J. Smith (Deanston), and R. Stevenson, Members; and J. Adams, P. N. Brockedon, E. F. Browne, J. Hoof, G. B. Maule, and J. Ransome, Associates.

The following gentlemen were elected to fill the several offices in the Council for the ensuing year:—William Cubitt, *President*: I. K. Brunel, J. M. Rendel, J. Simpson, and R. Stephenson, M.P., *Vice-Presidents*; G. P. Bidder, J. Cubitt, J. E. Errington, J. Fowler, C. H. Gregory, J. Hawkshaw, J. Locke, M.P., J. R. M'Clean, C. May, and J. Miller, *Members*; and J. A. Lloyd, and F. C. Penrose, *Associates of Council.*

January 14, 1851.

William Cubitt, Esq., President, in the Chair.

"On the Construction of the Building for the Exhibition of the Works of Industry of all Nations, in 1851," by Mr. M. D. Wyatt, Assoc. Inst. C.E.

The subject naturally divided itself into the consideration of the requisites demanded, the design, and the actual construction of the building

The features of all the buildings in which previous exhibitions had been held, both abroad and at home, were then carefully reviewed, and the points of difference between the present cosmopolitan exhibition and all its predecessors were distinctly enunciated, and shown to have induced the invitation to the world at large, to contribute their suggestions for the building, the results of which were shown to the public in the Theatre of the Institution of Civil Engineers, in the two hundred and forty plans there exhibited. None of these plans being found to embrace the necessary requisites, the Royal Commissioners devised a plan, for the execution of which tenders were invited in June, 1850.

The reservation having been made, that *bona fide* tenders for any construction, offering greater advantages than that proposed by the Commissioners, would be considered, Mr. Paxton brought forward his proposition; and it being contended, that certain advantages in celerity of construction, facility of removal, the adaptability of the materials to the required forms, and the amount of cost, were inherent in the design for the proposed structure, to be entirely composed of wood, iron, and glass, the other tenders were rejected, and that of Messrs. Fox, Henderson, and Co., for Mr. Paxton's design, was accepted.

Such was the origin of the present building, which being adapted to the site selected for it in Hyde Park, by H.R.H. Prince Albert, was shown to consist of a nave 72 feet wide, and 64 feet high, with a series of side aisles, two of 48 feet and six of 24 feet wide, of the respective heights of 43 feet and 25 feet; the whole spreading to a width of 436 feet.

A transept, 408 feet long, and 72 feet wide, intersected the building at right angles in the centre; this transept was covered with a semicircular roof, springing at a height of 64 feet from the level of the ground, and making the entire height 100 feet.

The details of the construction were very minutely given, from the concrete filling of the holes in the ground, under each support, through the base plate, the columns, 8 inches in diameter, the connecting pieces, to which were attached the girders for the galleries, the second and third sets of columns and the roof trusses, the box gutters and the "Paxton" gutters, which latter were intended to provide at the same time for conveying away the rain from the roof, and the condensed moisture from the inside. The total area of the ground-floor was equal to 772,784 square feet, and that of the galleries to 217,100 square feet.

Details were also given of the mode of conveying the rain water, &c., into the adjoining sewers, through the interior of the supporting columns; of the ventilation by means of sets of louvres, of galvanized cast-iron, placed between the columns of the side aisles, and in the upper part of the roof; of the supply of water for the extinction of fire, and for the supply of the fountains; and of the experiments for testing the girders and trusses, by the hydraulic press erected in the building, and by which the strength of the whole was proved before they were used.

In examining the power and dexterity with which the design had been realized by Messrs. Fox, Henderson, and Co., or, in other words, in the actual construction of the building, it was necessary to bear in mind, that their tender was only verbally accepted on the 26th of July, 1850; that possession of the site was obtained on the 30th of July; that the first column was fixed on the 26th of September; and at the present time (only 145 working days since the commencement) but little of the vast building remained to be finished. To give an idea of the vast size of this building, it was noticed, that the width of the main avenue was within 10 feet double that of the nave of St. Paul's Cathedral, whilst its length was more than four times as great. The walls of St. Paul's were 14 feet thick, those of the glass building in Hyde Park were only 8 inches. St. Paul's occupied 35 years in building, whilst the Hyde Park building would be finished in less than half that number of weeks. The celerity of the construction was very remarkable. As many as 308 girders had been delivered on the ground in one week. Seven of the great trusses of the nave were raised in one day. Each man fixed about 200 superficial feet of glass per day.

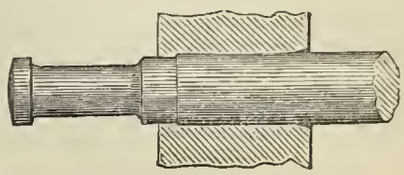
In order to perform this work, it was necessary to devise and employ various contrivances for economising labour; such as the sash-bar machine, the gutter machine, the mortising machine, the painting machine, the glazing machine, besides many others of an equally ingenious nature—all of which were described; and, when listening to the details, it was universally felt that England possessed mechanical and physical energies, far exceeding those which gave form and being to the most celebrated monuments of antiquity.

In the course of the paper, Mr. Digby Wyatt (the author), to whom, from the commencement, had been intrusted the active superintendence of the construction of the building, paid a well-merited tribute of praise to Mr. C. H. Wild and Mr. Owen Jones, who had been associated with him; to Mr. Barry and Mr. Brunel, who, as members of the Building Committee, had made very valuable suggestions; as well as to Messrs. Fox and Henderson, and to Mr. Brounger, Mr. J. Cochrane, and others, for their exertions in the execution of the construction; and he concluded by reminding the members, that the weight of responsibility, the arduous duty of supervision, the honour of acting as the master-mind, to weigh the requisites, to determine the design, and to govern the construction of this great apparatus, had been reserved for Mr. Cubitt, the President of the Institution of Civil Engineers.

INSTITUTION OF MECHANICAL ENGINEERS.

October 23, 1850.

"On the Form of Railway Axles."—At the conclusion of Mr. Thorneycroft's paper on this subject, as reported in our December part, an animated discussion took place between several practical railway men. In the course of this, Mr. Slate observed, that he had suggested the introduction of a small shoulder, inside the boss of the wheel, as in our sketch. This, he thought, would have all the advantage of the shoulder at the inner side of the boss, without weakening the axle at all. The wheel is bored out a tight fit, and forced on the axle by a press; the first 1½ inch on the inner side being slightly coned, so as to remove the grip on the axle from the extreme edge of the boss.



"On Railway Carrying Stock," by Mr. W. A. Adams, of Birmingham.

The object of the present paper is to discuss and analyse the various descriptions of railway carrying stock, with the purpose of suggesting such improvements in the details of form and manufacture as will materially reduce the gross or dead weight of the vehicles, without affecting their efficiency or strength.

This matter has been brought prominently under the writer's attention, from the fact that upon leading lines of railway the first class carriages for the conveyance of eighteen passengers have reached a gross weight of 5 tons, and waggons for the conveyance of a maximum load of 5 tons, have reached a gross weight of 4¾ tons. These, it is to be observed, are probably extreme cases, but being modern they evidence the tendency to increase the weight of trailing stock.

It is scarcely needful to remark, that if a locomotive engine is capable of conveying a train of fifty waggons weighing 200 tons, and the load 200 tons (which proportion will not be short of the truth, even without taking empties into account), a saving of *one ton* in the weight of each waggon will enable the engine to convey 50 tons additional of waggons and load, or equal to a saving of *one-eighth* in the cost of haulage.

In the important matter of inland through coal traffic, the waggon averaging 3 tons 15 cwt. carries 5 *tons* of coal. But as the waggon of course returns empty, for 5 tons of coal conveyed one mile, 7 tons 10 cwt. of waggon has been conveyed the same distance.

In this instance the saving *one ton* weight in the construction of the waggon would be equivalent to a total saving of nearly *one-sixth* in the cost of haulage;—that is to say, if the present rates are remunerative, the prices may be reduced 16 *per cent.*, inducing a much more extensive traffic, and better enabling railways to compete with water conveyance.

Inland coals are mostly conveyed in waggons belonging to the collieries, or rented to the collieries by private individuals. In either case the tonnage or mileage charges on the railways being irrespective of the weight of waggon, the object of the waggon owner is to produce such waggons as will be most durable with the smallest amount of first cost. The weights of colliery waggons have been gradually increasing, each new lot being made (as was recently observed by the manager of an extensive inland colliery) of such a strength and weight, that in the event of a collision, they may break their neighbours and remain uninjured themselves.

Engine and carriage superintendence are generally distinct departments. The carriage superintendent aims at the utmost economy of maintenance in his department, and produces carriages and waggons which, though very lasting and very serviceable, are meanwhile greatly increasing the expenditure of the locomotive department. It would appear that in no case has the interest of the parties directly concerned been to decrease the weights of the vehicles.

The heavy trains handed over to the locomotive department to haul, induced the construction of more powerful and weightier engines, until the maximum was quickly reached, and checked by the sufferings of the permanent way. It is to be observed that the writer has no desire to carry the question of light vehicles to any Utopian extent, but simply to calmly study and elucidate, by experience and experiment, the practical means of reducing the weights of vehicles within proper bounds.

At the period of the commencement of railways, passengers were mostly conveyed by four-horse coaches, light goods by vans, and heavy goods by water. It is the intention of the writer of this paper to confine the inquiry to wheel vehicles.

The great distinction between road and railway vehicles is, that railway vehicles have to sustain longitudinal strains in the direction of the buffing, as well as lateral and perpendicular blows.

The four-horse coach, weighing 19 cwt., conveyed 18 persons, with luggage, weighing in all 1 ton 7 cwt., at a rate of 10 miles per hour.

The four-horse Brighton van, weighing 1 ton 11 cwt., conveyed 6 tons of goods at a rate of 4 miles per hour.

Every pound was carefully saved in weight of construction in the above vehicles. The timber was carefully-selected English ash; not that ash was the most lasting and durable, but that, for strength and toughness, it was unequalled in lightness, though short in its period of duration.

The axles and the iron-work were wholly made of the best marks of scrap-iron. Skilled and costly labour of a high class was employed in the forging and fitting of the iron-work and the construction of the wood-work. In all cases where extreme strength was required, the timber was carefully plated with iron; obtaining the utmost strength with the smallest amount of material.

Builders competed, not so much in price, but as artists, to produce, by proportion of parts and materials, the utmost result with the least weight. The gradients were bad, the roads imperfect, the motive power limited. The wear and tear of the carriage was a secondary consideration to the cost of hauling power. The vehicles were probably as near perfection as man's ingenuity could produce them.

Simultaneous with the four-horse coach and van, was the conveyance of coals upon tramways with horse-power.

The writer will confine his observations to that district with which he is practically acquainted, that of Monmouthshire. The act for the making of the Sirhowy and the Monmouthshire tramways—a total length, exclusive of branches, of 26 miles from the mines and iron-works to the shipping port of Newport—was obtained in the 42d year of George III., and consequently forty-eight years since, and that tramway has been worked until within the last twelve months by horse-power.

Originally it was a tramway with fish-bellied cast-iron plates, laid and jointed upon stone-blocks, with 6 feet bearings. These have gradually given place to rolled plates of malleable iron, weighing about 80 lbs. to the yard, and laid in chairs upon cross wood sleepers, with 2 feet 8 inch bearings.

The gross weight of the *tram* waggon was 16 cwt., and it carried 3 tons of coals at a rate of 3 miles per hour, exclusive of the time consumed at the various public houses by the tramway side.

The breaking or skidding down the inclines was effected in the most complete manner, by means of a slipper or shoe, similar to that of a stage-coach, and the stopping of the train by thrusting a bar of wood through the spokes of the wheel, or, as it is locally termed, spragging the wheel. The unloading was effected by means of a gallows and crab, the tram being raised at one end, and the coals discharged by means of the swinging tail-board at the other end.

It will be observed that no provision is made for buffing, but that the train is articulated by means of the hitching, as shown in the drawing. The wheels ran loose upon the axles, and were, in most instances, dished in the manner of a common road wheel, thereby illustrating the first advance from a common road vehicle.

The tramway is mostly an inclined plane from the mines to the port. Six horses brought down 60 tons of coals, and 16 tons of trams. The same power was required to take up the empty trams. Dead weight in the trams was consequently of vital importance.

This tramway is now being worked with locomotive power and permanent waggons, the tramway company finding power, and the freighters waggons. The same care, which influenced the private haulier and caused him to equalize his upward to his downward load, does not now influence the freighter, and has been lost sight of by the company. In the eye of the freighter the waggon which is strongest and heaviest is the best, and the consequence is, that waggons weighing 3 tons are conveying but 5 tons of load.

The ratio of upward load was in the one case 21 per cent., and in the latter 37 per cent., as compared with the downward.

The weight of waggon conveyed up hill, was in the one case 27 per cent., and in the latter 60 per cent., as compared with the coals brought down.

In place of a perfect horse tram-road heavy engines are being hammered, and are hammering to pieces a bad road with bad gradients and extremely bad curves. This is wholly true, but fortunately an extreme case; nevertheless it is questionable whether many lines are not also suffering in a lesser degree from the incubus of dead weight.

The Huntingdon and St. Ives' branch of the East Anglian Railway, 4¾ miles in length, is at the present time worked by a horse carriage. This carriage is a composite carriage consisting of three compartments, and carrying 60 passengers in all, inside and out.

It is to be observed that the carriage is made from an ordinary composite, the under frame being completely taken away, and wheels, guards, and springs of the lightest construction substituted. The total weight is three tons; but the weight would not exceed two tons, if the carriage had been originally built for the present purpose. The horse is attached by an outrigger, to which the traces are hooked, and he travels by the side of the carriage, with his head tied up to the carriage to prevent him from turning round. A break is applied to the wheels.

The writer has instanced this carriage to illustrate that, when horse-power is brought into use, the weight of vehicle is at once considered; and also that the vehicle being used singly does not require strength to resist longitudinal buffing. The cost of working this carriage is sixpence per mile, including horse and driver, and the guard, who is also ticket collector.

The pace is ten miles per hour, and it would appear that this application meets all the requirements of the limited traffic of a short branch.

Rapid strides were made by engineers in perfecting the way and the locomotive. The facts relative to the permanent-way have been discussed and appreciated, and the details greatly perfected. Locomotives have been improved, the consumption of fuel brought probably near to the minimum; the details have been understood, discussed, and experimented upon by men of high talent and experience.

But far differently with the matter of the carrying stock. The construction of the carriage and the waggon was in the commencement left wholly to men of long practice in carriage-building for the common road, but not experienced in mechanical engineering.

Those patterns originally set, have been copied and re-copied in an almost servile manner. When carriages and waggons have failed in their parts, the sole remedy has been increase of strength, by increasing the weight and quantity of material. Axles have increased from 3 inches diameter to 4 inches; tyres from $4\frac{1}{2} + 1\frac{1}{4}$ inches to $5 + 1\frac{3}{4}$ inches, and so throughout.

In the original London and Birmingham and Grand Junction first-class carriages, with three compartments, carrying 18 passengers, the dead weight is $3\frac{1}{4}$ tons; cubical contents 504 feet.

In the modern first-class carriage, with three compartments, carrying 18 passengers, the dead weight is 5 tons; cubical contents 807 feet.

The dead weight of waggon, per ton of load, for the upward and downward journey of the—

Old Monmouthshire train, ½ ton.

New Monmouthshire waggon, 1⅓ ton.

Derbyshire and Leicestershire coal waggon, 1½ ton.

The writer presumes that it will be at once admitted, that reducing the dead weight of railway vehicles is extremely desirable, whilst such reduction of weight is effected with due regard to efficiency and strength to resist the longitudinal strain in buffing. Also, that reduction in first cost is not the sole object to be attained, but to produce such vehicles as shall be, all points considered, the most economical in first cost, in maintenance, and especially in traction; but at the same time it does not follow, that reducing the dead weight and improving the quality of the materials shall add materially, if any, to the cost.

Should it be approved by the Institution, the subject of a second paper will be to analyse and compare the whole of the modern trailing stock with that of an earlier period, and thereby glean such information as will enable the writer to prepare and lay before the Institution, in a future paper, such improvements in the form and manufacture of railway vehicles as may lead to the result pointed out at the commencement.

It is proposed to try all necessary experiments as to the relative strength of wood and iron, and the combination thereof, in order to obtain the necessary information as to the most eligible and economical means of attaining the greatest strength with the least weight.

SOCIETY OF ARTS.

Nov. 27, 1850.

MR. HENRY THOMAS HOPE, M.P., VICE-PRESIDENT, IN THE CHAIR.

Mr. Mechi read a paper on the present state of agriculture in England, and on his own farming operations at Tiptree Hall, Essex.

Mr. Mechi commenced by adverting to the slow progress made by agriculture as compared with that of other industrial occupations, and to the terrible necessity for still further improvement imposed on us by our rapidly-increasing population—improvement which a long list of works in reclamation of waste land showed to be both possible and profitable. His reasons for dissatisfaction are the low annual value of the acreable produce of the kingdom.

I have good reason to believe that the very largest estimate per acre, taking into account the poor grass and arable lands, and leaving out market and other gardens, does not reach £4 per acre. A reference to Spackman's Occupations of the People, and other statistical works, will show that the rental of the united kingdom (excluding towns) will certainly not reach 15s. per acre. Taking, therefore, as a gross return, five rents (four would be nearer truth), it is clear that £3. 15s. worth of produce per acre is far too liberal an estimate· £3. 15s. from one whole acre of land in the nineteenth century!

But well-known facts show that, by the use of better cultivation, and a better general method of farming, much larger returns can be got.

Even this year, some of my own potato land has yielded £15 per acre, at the low price of 1s. per bushel; and the average of my 80 acres of wheat will not be less (straw and chaff included) than £10 per acre, on a very miserable soil. There are in—

	Acres.	Rental per Acre.
England and Wales	36,995,000	21s. 8½d.
Scotland	18,944,000	5s. 1½d.
Ireland	20,177,446	13s. 5¼d.

(including the towns, and all the bog and waste lands.)

Now, the mere increase of labour and production to the extent of only 10s. per acre, would afford us all food and employment, without recourse to foreign imports. This object must be attained by the free-will of a free people, stimulated by public discussion, comparison, and calculation. I am not one of those who think that scarcity and high prices are preferable to abundance and cheapness. I hold it as a principle, that a nation that can supply itself abundantly with food and manufactures, and still have a large surplus of the necessaries and comforts of life to exchange with other nations for luxuries, is in a happy and prosperous condition.

The surplusage of our manufactures forms an important element in the wealth of the country; but our agriculture produces no superabundance, and I venture to predict that it will never be rich until it does.

I have been forcibly struck with the prejudices and inconsistencies of agriculture. The railway-hedges are neatly trimmed and annually cultivated, like a crop of turnips, and they are thus rendered effective as well as neat. The farm-hedges, diverging at right angles from these, have never caught the pleasant infection. They still exhibit their huge, irregular, and ungainly proportions; shading and robbing the land, for the mere purpose of growing bushes to stop the gaps caused by their untrimmed and neglected condition.

Farmers dig their gardens two feet deep, but only plough their land five inches. They take especial care of their nag horses in a good warm stable, but expose their farm horses and cattle to all weathers. They deny the utility of drainage in strong tenacious clays, but dare not dig an underground cellar in such soils, because the water would get in. They waste their liquid manure, but buy guano from Peru to repair the loss. I have known practical men seriously doubt the benefit of liquid manure, who are in ecstacies with the urine of the sheepfold. But I am asked, 'Where is the capital to come from for all these improvements?' I reply, Where *does* the capital come from to make railways and docks, to build steam vessels, to erect a whole town of new squares and streets, and to carry out every other useful and profitable undertaking?

I see in mental review a long list of bankers, merchants, shipowners, manufacturers, traders, and professionals, who have become owners or cultivators of our soil. These, not having the agricultural precedents or prejudices of their predecessors, are devoting their powerful means and energetic common-sense principles to the amendment of our agriculture, and the increase of employment and of food. If you see arising on the ruins of our queer-shaped and antiquated farmeries a pile of substantial and convenient erections—if you see the smoking shaft and irrigated meadow, depend upon it it is the work of some new possessor. The establishment of public companies, with ample capital and sufficient legal powers to improve settled or encumbered estates, is also a pleasing event.

The antiquated and semibarbarous difficulty of transfer is a sad and most unjustifiable obstruction to landed investment and amendment. It appears to me a monstrous and intolerable nuisance, that the same principles of possession and transfer are not applied to land as to the funds. A public registry-office, with district maps, would at once obviate the difficulty. Land would then change hands twenty times for once now, and have a proportionably increased chance of improvement.

A painful question is often asked, 'What is to become of the poor farmer?' I reply, What *has* become of the poor hand-loom weaver—of the four-horse coach proprietor—of the roadside innkeeper—of the turnpike trusts—of the Gravesend sailing-boats—of the old hackney coaches? Even the poor old watchmen, who called the hours all night, and cleaned boots and shoes half the day, have given way to the able, active, and efficient new police. These are days of movement and progression, and agriculture can no longer withstand the common fate. The poor farmer and the poor landlord, or rather those who are in a wrong position, will necessarily make way for more useful members of society. It is a painful though national necessity.

With regard to the practice of agriculture, there are certain things on which, from experience, I am competent to pass a decided opinion, and recommend as economical and profitable.

The Agricultural Labourer.—The moral and physical condition of our labourers has, in my opinion, a most important influence on our successful cultivation of the soil.

It seems marvellous that, with the example o America before us, we should still leave this great question to the mere chance of individual or local beneficence. Our Scotch friends manage this matter better, and with economy too; and, as a consequence, supply us with bailiffs and gardeners.

I find it advantageous to myself and to my labourers, to let every job, task or piece-work. The work is more quickly and cheaply done; the men earn more money; are consequently in a better physical and social condition, and larger consumers of the farmers' and manufacturers' produce.

Every man who values the working condition of his horses will naturally extend the same consideration to his labourers. The social and physical pestilences resulting from the wretched hovels in which they are compelled to live, should make us wiser in this respect. Honour be to his Grace the Duke of Bedford, and to others, who have set a brilliant example, by providing ample and convenient residences for the peasantry on their estates.

Good Farm and Parish Roads.—The necessity for facility of carriage is obvious. In the good old times, which I by no means desire to resuscitate, the father of a friend of mine, when a farmer in Surrey, had to send his wheat to market twenty miles on pack-horses, and sell it at 20s. per quarter!

Our parish and farm roads are, many of them, sadly managed; they should always be kept slightly rounding, so as to shoot off the water, scraped, repaired, and drained, like our turnpike roads.

Farm Horses.—Farm horses should be clipped early and gradually, piece by piece. If you doubt this, try on your plough one clipped and the other unclipped, and you will soon come to a conclusion. They should never be turned out, but treated exactly as your nag horses, taking especial care that there should be ventilation at the highest point in the stable. All their hay and straw should be cut up into chaff, the corn ground into meal, and mixed with it. Two-thirds hay-chaff and one-third straw-chaff is the right proportion; but cut hay alone does not answer, being apt to ball in the stomach. If their water could always be warm, as at the London breweries, they might drink at any time.

Animals never do well under slated roofs, unless you interpose a lining of boards or thick woollen felt. Slates conduct heat *to* the animal in summer, and *from* it in winter. Thatching under slate is useful, though apt to encourage vermin.

Deep Cultivation after Drainage is essential to profitable farming on heavy lands. I effect this by removing the breast from a plough, and letting it follow, drawn by a pair of horses, in the track of the first plough. In summer I use a very large plough with four horses, to open the work, and follow with another plough and four horses in the same track. This brings up immense clods and blocks of the nasty undisturbed subsoil. When dried by the sun, the Crosskill roller, with 5 cwt. added, cracks them, the scarifier operates, and again the Crosskill renews the attack, all in dry hot weather, until you have a perfect garden, yellow-looking, it is true, but aerated, and deprived of many noxious properties, and ready for mixing with abundant manure and calcareous matter You thus bid adieu to root-weeds that have tormented you for years, you facilitate the percolation of water, air, manure, and roots. Your crops do not dry up in summer, or freeze in winter; for it is the drying or freezing of the *roots* that destroys the plant.

I apprehend that, if a pair of horses could plough two feet deep instead of five inches, *that* would have been our general depth of cultivation.

This dry summer, all the manure for our root crops being within five or six inches of the surface got dried, and the root crop failed. Not so where it was buried deeper, like garden cultivation, below the solar influences. Our root crops send down their roots many feet in summer, provided the manure is there, as I have proved by examination.

The Potato Question.—Bad farmers, who do not keep much stock or buy much manure, *dare not* grow potatoes with the ordinary mode of farming. I have heard them say a potato crop exhausts their land for years. But a heavy exhausting crop implies a heavy return, with means for restoring the deficiency occasioned by it. Miserable crops, occasioned by the save-all and cheese-paring principle, cause us to feel severely the pressure of our rent, tithes, and rates. They react on the landlord, labourer, tenant, and community at large.

MONTHLY NOTES.

Interior Decorations of the Exhibition Building.—Mr. Owen Jones, who has undertaken the arduous task of decorating the interior of the building, has all along sustained a good deal of rough handling from a portion of the press, as well as from some individuals who, on very slight grounds, have constituted themselves judges of colour. Amongst so much carping criticism, the public, of course, have some anxiety as to the effect actually produced. We have ourselves examined it so far as it has proceeded, and in our opinion the effect is all that can be desired. The colours are melted together, and toned down in the distance to a light airy neutral tint, agreeing remarkably with the peculiar fairy-like elegance of the interior. It is tolerably certain that the greater number of Mr. Jones' opposers would now alter their previously-expressed opinions, if they had not committed themselves too far for retreat

Steam Communication between the Clyde and the Thames.—The direct railway distance of London from Glasgow is rather over 400 miles, the ocean track round the land's end somewhere about 1,000; yet it is now a weekly fact, that it is found worth while to send a steamer back and forward by this lengthy route. The *European* screw steamer, recently built by Smith & Rodger, sails every alternate Saturday from these widely-sundered ports, and so far with every prospect of commercial success. Her last run, from Greenock to Gravesend, was performed in 73 hours, the whole time throughout, to London Bridge, being only 76 hours. This trip was accomplished by steam alone, no canvas having been set during the voyage. When it is remembered that cargoes transmitted by this channel are conveyed to their destination without reshipment or any other removal, and in so short a time as we have mentioned, it is easy to see the effect the new scheme will have in transferring the sea traffic from the east to the western coast, and even in interfering in some degree with railway conveyance.

Self-Acting Safety Boat-Plug.—Amongst the late proposed improvements upon life-boat fittings, is a very simple self-acting contrivance by Mr. Charles Owen, the engineer of the Dundee Harbour. Mr. Owen's plug is neither more nor less than a valve which remains open by its own weight, so long as the boat is suspended from its davits, or otherwise clear of the water; but immediately that the boat is afloat, the external water-pressure closes it. In conjunction with Mr. Clark, the ship-owner, the inventor has recently tested the practical working of the new plug with a most satisfactory result.

Diminutive Locomotives.—With the instructive teachings* of Messrs. Samuel, Adams, England, and others, as to the success of the carriage engine or small locomotive system—before us, it is matter for surprise that light trains, with frequent despatch, have not made further way. With the exception of a single miniature engine by England, on the Edinburgh and Glasgow line, and one or two moderately small ones by Neilson & Co., on the Bowling and Lochlomond line, nothing appears to have been done either in England or Scotland since the early Eastern Counties' experiments. Some time ago a movement was made to endeavour to place Adams' carriage engines on the short branch from the Clyde at Renfrew to Paisley, now worked by horses, but the scheme apparently fell through. A very good opportunity, amongst many others, for testing the system in working through traffic of a moderate length of run, is to be found in the Glasgow and Greenock line. We are persuaded that a trial on this line would have a favourable result, in showing what yet remains to be done in securing a greater proportion of paying load to dead weight, less injury to the permanent way, and general economy in working.

* Pages 193 and 275, Vol. I.

ENGLISH PATENTS.

Sealed from 16th January, to 11th February, 1851.

Richard Bycroft, Paradise Wolsoken, Norfolk, gentleman,—"Improvements in apparatus to be used by persons to secure warmth and dryness when travelling."—Jan. 18th.

George Normard, Shoreditch, Middlesex, cabinet-maker,—"An improved cooking and boiling apparatus."—18th.

George Frederick Munty, jun.,—"Improvements in furnaces applicable to the melting of metals for making brass, yellow metal, and other compound metals."—18th.

John Lienard, jun., Wharf-road, City-road, Middlesex, merchant,—"Improvements in purifying or filtering oils and other liquids."—18th.

William Rees, Pembrey, Carmarthensbire, coal agent,—"Certain improvements in the preparation of fuel."—18th.

Edmund Pace, of the firm of Taylor and Pace, Queen-street, London, iron-bedstead makers,—"Certain improvements in bedsteads, couches, chairs, and other like articles of furniture."—21st.

George Elliot, St. Helens, Lancaster, chemist,—"Improvements in the manufacture of alkali."—21st.

William Burgess, Newgate-street, London, gutta percha dealer,—"Improvements in machinery for cutting turnips and other substances."—21st.

Robert William Sievier, Upper Holloway, Middlesex, gentleman,—"Improvements in weaving and printing or staining textile goods or fabrics."—21st.

Charles Roper Mead, Charlotte Cottages, Old Kent-road, Surrey, mechanical engineer,—"Improvements in apparatus for measuring gas, water, and other fluids."—21st.

John Ransom St. John, New York, United States, America, engineer,—"Improvements in the process of and apparatus for manufacturing soap."—21st.

Samuel Clift, Bradford, near Manchester, manufacturing chemist,—"Improvements in the manufacture of potash, soda, and glass."—21st.

Auguste Loradoux, Bedford-street, Strand,—"Certain improvements in machinery or apparatus for raising water and other fluids."—(Being a communication.)—21st.

Alexander Samuelson, Banbury, agricultural implement manufacturer,—"Improvements in apparatus for cutting turnips, carrots, mangold-wurzel, and other vegetables."—23d.

Joseph Bunnett, Deptford, Kent, engineer,—"Certain improvements in public carriages for the conveyance of passengers."—23d.

Joseph Crossley, Halifax,—"Improvements in the manufacture of carpets, rugs, and other fabrics."—28th.

Samuel Morand, Manchester,—"Improvements in apparatus used when stretching and drying fabrics."—30th.

Benuet Woodcroft, Furnival's-inn,—"Improvements in machinery for propelling."—30th.

James Murdoch, Staple-inn, Middlesex,—"Certain improvements in preserving animal and vegetable substances."—(Being a communication.)—30th.

Charles Gotthelf Kurd, Paris, France, engineer, and Charles Alexis de Wendle, ironmaster, also of Paris,—"Improvements in the process and instruments to be used for boring the earth, and sinking shafts of any given diameter, for mining and other purposes, and in the means of lining such shafts."—30th.

Alfred Vincent Newton, Chancery-lane, Middlesex, mechanical draughtsman,—"Improvements in manufacturing looped and other woven fabrics."—(Being a communication.)—30th.

Richard Johnson, Manchester, wire-drawer,—"Certain improvements in annealing articles of iron and other materials."—31st.

Juan Neponniceno Adorno, Golden-square, Middlesex, gentleman,—"Improvements in the construction of maps and globes, and in apparatus for mounting the same."—31st.

Charles Marsden, Kingsland-road, Middlesex, engineer,—"Certain improvements in boots and shoes."—31st.

George Bradshaw, Bishopsgate-street Within, London, hosier,—"Certain improvements in fastenings for garments."—31st.

Jean Paul Gage, Paris, France, chemist,—"Improved chemical compounds for tissue bandages, wafers, and also for surgical purposes."—31st.

David Davies, Wigmore-street, Cavendish-square, Middlesex, coach-maker,—"Certain improvements in the construction of wheel carriages, and in appendages thereto."—31st.

John Davie Morris Stirling, Black Grange, North Britain, Esq.,—"Improvements in the manufacture of metallic sheets, and coating metals, in metallic compounds, and in welding."—31st.

Samuel Allen, jun., Birmingham, manufacturer,—"Certain improvements in the manufacture of buttons."—Feb. 1st.

Nathaniel Jones Amies, Manchester, manufacturer,—"Certain improvements in the manufacture of braid, and in the machinery or apparatus connected therewith."—1st.

Alfred Vincent Newton, Chancery-lane, mechanical draughtsmen,—"Improvements in communicating intelligence by electricity."—(Being a communication.)—3d.

Alexander Alliott, Lenton Works, Nottingham, engineer,—"Improvements in cleaning, dyeing, and drying machines, and in machinery to be used in sugar, soap, metal, and colour manufacturing."—3d.

Benjamin Ledger Shaw, Huddersfield,—"Improvements in cleaning and preparing wool and other fibrous or textile materials, and in the manufacture of coloured yarns of wool and other fibres, and in weaving."—5th.

Angier March Perkins, Francis-street, Regent-square, Middlesex, engineer,—"Improvements in railway axles and boxes."—5th.

Charles De Bergue, Arthur-street West, London, engineer,—"Improvements in and in the construction of the permanent way of railways."—7th.

Frederick R. Robinson, Bolton, Massachusetts, United States of North America,—"A new and useful sewing machine."—7th.

William Onions, Southwark, Surrey, engineer,—"Improvements in the manufacture of certain parts of machinery used in spinning."—7th.

William Onions, Southwark, Surrey, engineer,—"Certain improvements in the manufacture of steel."—7th.

François Marcelin Aristide Dumant, Paris, engineer,—"Improved means and electric apparatus for transmitting intelligence."—7th.

William Edward Newton, Chancery-lane, Middlesex, civil engineer,—"Improvements in apparatus for milking animals."—10th.

Peter Fairbairn, Leeds, machinist, and John Hetherington, Manchester, machinist,—"Certain improvements in mouldings for casting pipes, railings, gates, agricultural implements, and other metal articles; and also in preparing patterns or models for the same."—10th.

Richard Stuart Norris, Warrington, Lancaster, civil engineer,—"Certain improvements in the construction of the permanent way of railways, bridges, locks, and other erections, wholly or in part constructed of metal; also improvements in breaks for railway carriages."—10th.

John Stephens, Allyards, Astley Abbotts, Salop, gentleman,—"Certain improvements in threshing machinery."—10th.

Joseph Haythorne Reed, late of the 17th Lancers, Harrow-road, gentleman,—"Improvements in saddlery and harness."—10th.

John Harcourt Brown, Fir-cottage, Putney, Surrey, gentleman,—"Certain improvements in the construction and building of ships, boats, buoys, rafts, and other vessels, and appliances for preserving life and property at sea."—10th.

Charles Xavier Thomas (de Colmar), Chevalier de la Legion d'Honneur, Paris, France,—"An improved calculating machine, which he calls 'Arithmometer.'"—10th.

William Wield, Manchester, engineer,—"Improvements in machinery for turning and burnishing."—11th.

Benjamin Heywood, Water-street, Manchester, coach-builder,—"Certain improvements in railway and other carriages."—11th.

George Briand, Nicholas-lane, London, surveyor, and Richard Fell, City-road, engineer,—"Certain improvements in obtaining fresh and pure water from salt, sea, and other waters."—11th.

Charles Howland, New York, America, engineer,—"Improvements in bell telegraphs."—(Being a communication.)—11th.

Angier March Perkins, Francis-street, Regent-square, Middlesex,—"Improvements in constructing and heating ovens."—11th.

James Webster, Leicester, engineer,—"Improvements in the construction and means of applying carriage and certain other springs."—11th.

DESIGNS FOR ARTICLES OF UTILITY.

Registered from 16th January, to 12th February, 1851.

Jan. 16th,	No. 2635.	George Ellis, Fore-street, City,—"Boa."
17th,	2636.	J. Solomon, Red Lion-square,—"Eye-protectors and concentrators of light for opera-glasses."
22d,	2637.	Hilliard and Thomason, Birmingham,—"Dress-fastener."
—	2638.	Unwin and Rogers, Sheffield,—"Cigar-holding pencil-case knife."
—	2639.	Myers and Son, Birmingham,—"Penholder."
—	2640.	W. A. Adams, Midland Works, near Birmingham,—"New form of angle iron."
23d,	2641.	R. Daintree, T. Ekins, and J. Nix, junior, Huntingdon,—"Potato-sorting machine."
—	2642.	J. G. Anon, New Bond-street,—"Boot, shoe, clog, or galosh."
—	2643.	W. F. T. Bradshaw, Sheffield,—"Bradshaw's improved potter's palette-knife."
—	2644.	J. C. White, Liverpool-street,—"Socket-piece for part of a brace."
24th,	2645.	B. Barling, E. Barling, and W. Barling, High-street, Camden-town,—"Catch top mount for smoking pipes, and other articles of manufacture."
—	2646.	R. M. Vick, Gloucester,—"Hames."
—	2647.	S. Weil and S. Flattan, Mile-end,—"Sock (for infants)."
—	2648.	J. Hawkins, Walsall,—"Bit for horses."
27th,	2649.	P. R. Jackson, Salford Nolling Mills, near Manchester,—"Stink-trap."
29th.	2650.	A. Graham, Glasgow,—"Gas cooking range."
—	2651.	W. Pulford, Boston,—"Archimedian nut-cracker."
—	2652.	W. Butterworth and Co., Great Dover-street, Southwark,—"Elastic boot legging."
—	2653.	W. Moat, Hammersmith,—"Fiddle bow."
30th,	2654.	Benjamin Goodfellow, Hyde,—"Fire-box and flue for cylindrical and other boilers."
—	2655.	Henry Dyer, Hungerford,—"Office index and memento."
31st,	2656.	John Ezra Dalphin, Whitecross-street,—"Self-adjusting churn."
—	2657.	Henry Wickens, Regent-street,—"Border piece or edging for a parasol."
—	2658.	Pease and Gardner, Bradford,—"Pressure gauge."
—	2659.	William Levesley, Park-terrace, Old Ford,—"Guard razor."
—	2660.	John Chatwin Stokes, Birmingham,—"Tap."
Feb. 1st,	2661.	Josh. Illingworth and Sons, Shipley,—"Adjustable eccentric tumbler for the slide valve of steam-engines."
—	2662.	Negretti and Zambra, Hatton-garden,—"Metallic scale thermometer."
3d,	2663.	John Gouger, Wood-street, Cheapside,—"Fastener for a shirt-collar, 'The Imperial.'"
—	2664.	George Piercy Tye, Birmingham,—"Spring label for tree and flower-pots."
—	2665.	F. J. Brewer, Birmingham,—"Window."
4th,	2666.	Benjamin Ridge, Putney,—"Invalid bed carriage."
—	2667.	Auguste Bessan, Friday-street,—"Coffee-pot."
—	2668.	James Higgins, Salford,—"Roving or slubbing frame spindle."
5th,	2669.	Archibald Kenrick and Sons, West Bromwich,—"Door-chain and case."
—	2670.	John Groves, Wolverhampton,—"Day indicator."
6th,	2671.	George Taylor, Wolverhampton,—"Self-correcting date clock."
—	2672.	Stock and Son, Birmingham,—"Soil-pan service-box."
—	2673.	William Pulford, Boston,—"Railway carriage roof candle lamp."
8th,	2674.	John Stafford Mackenzie, Newark-upon-Trent,—"Triturator."
—	2675.	Samuel Salter, Watford,—"Opening and valve for admitting air from the ash-pit of a furnace, so as to inflame the products beyond the bridge of such furnace."
—	2676.	William and John Sangster, Cheapside,—"Apparatus for destroying insects on trees."
10th,	2677.	George Knowles, Wood End, Scarborough,—"Illuminating gas-stove."
—	2678.	Carnell and Hosking, Perran Foundry, Cornwall,—"Treble beat hydraulic valve."
—	2679.	Charles Frederick Trelawney Young, Stockleigh, Pomeroy,—"Rotary boot and shoe-cleaner."
—	2680.	Charles Hubert, Regent-street,—"Shape for cutting the front and quarters of a boot in one piece."
11th,	2681	Henry Andrew Dewar, Aberdeen,—"Hinged clasp for holding artificial teeth."
—	2682.	Roberts and Hall, Sheffield,—"Toast rack"
12th,	2683.	B. and J. Harcourt, Birmingham,—"Match-box."
—	2684.	Wassall and Pitt, Birmingham,—"Universal penholder."
—	2685.	John H. Hutchinson, Grantham,—"Sleeve lining for garments."
—	2686.	John Mackintosh, Robert-street, Adelphi,—"Apparatus to be used to make boats more safe at sea."
—	2687.	Carnell and Hosking, Perran Foundry, Cornwall,—"Treble beat hydraulic valve."

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J. W. Leith.—We have written him by post.

J. W.—His sketches will appear next month. They are now in the engraver's hands.

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